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POWER

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Our Engineer President

WHEN this goes to press there will be, for the second time in the history of our country, an engineer at the head of its government.

Herbert Hoover has already demonstrated, in a career of public usefulness, the effectiveness of the engineering type of thinking and application in getting worth-while things done.

He is an advocate of individualism, of keeping opportunity open to private initiative and of encouraging returns to enterprise and exercised ability.

But he has, too, the engineer's appreciation of the growing interrelation of the factors that make up our national life; of their increasing dependability upon one another, and how essential it is to communal efficiency and universal well-being that they should function smoothly in unison instead of at cross purposes, setting up internal stresses in the social and industrial structure.

He realizes, as few statesmen have realized, that there must be unity of purpose among these, abstention from the taking of unsocial advantage, conviction that their combined rôle is service to the public and co-operation in performing it.

As Secretary of Commerce he has done much to organize our national housekeeping, to regiment business and industry, to eliminate industrial waste; and he has done it in the way of the advising specialist, with the consent and assistance of the patient, and not in the way of the policeman with his club.

One of the aftermaths of the war, he says, is the bringing about of two schools of thought—"one that all human ills can be cured by government regulation, and the other that all regulation is a sin."

Under his guidance we may look for an early and sound solution of the several large engineering problems now before the nation, in the study of which he has been already active.

All set, Mr. Engineer, for a prosperous and happy trip. En Route!

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Industrial Steam Cost Is Vital

OF LATE there has been a decided trend on the part of industrial power plants to adopt advanced means and methods found in public utility practice to be both practical and economical. In fact, there are several instances of industrial plants showing the way in the adaptation of some of the more advanced ideas of steam generation. With business becoming more complex, competition keener, and the growing use of power and steam in varied processes, it is not only desirable but obligatory that the power costs of industrial plants be guarded closely and means of decreasing them be given careful consideration.

In the present set-up of most plants the power costs are a vital part of the manufacturing costs, and the industrial plant that can either generate or procure purchased power at a cheaper rate than a competitor has a decided advantage and a greater opportunity for profit. As a rule, the price of labor for a given industry is fixed; the raw materials vary, but to all alike. On the other hand, the cost of power depends on the guiding hand of the plant engineer and the equipment he has to work with.

The Decatur, Illinois, plant of the A. E. Staley Manufacturing Company, manufacturers of corn products, is not unlike other large plants of its kind. Competition is keen, production is on a large scale, and the items of power and industrial steam are vital parts of the manufacturing process.

For years it has been a consistent policy with this company to keep thoroughly posted on modern trends in steam generation and, by comparative study of the various developments, accept or adapt that which seems best suited for its particular needs. In a recent endeavor to improve combustion efficiency and increase boiler capacity for a given floor space, a boiler differing somewhat from standard and a special water-cooled furnace served by two unit mills have been developed. The details, found elsewhere in this issue, will be interesting.

Real engineering work, such as this, must some day become the rule rather than the exception in industrial plants. With it will come marked decreases in the cost of the power services without sacrifice of quality.

Coal Carbonization and the Boiler Plant

LOW-TEMPERATURE carbonization of coal has undoubtedly received more attention than it merits, at least in the United States. Whatever may be the interesting possibilities held out by this process, economic conditions in this country are not such at the present time as to warrant any great investment in it when based upon the same grounds as the development abroad.

In Europe, particularly in France, Germany and Great Britain, the urge to progress in this line arose from a lack of petroleum resources and a scarcity of smokeless, domestic fuel. Under these conditions low-temperature carbonization, which produces tar oils that can replace natural oil and a low-volatile, smokeless semi-coke that is suitable for house-heating purposes, seems to be economically justified. The relatively high prices commanded by these products in lands where the natural fuels are scarce allows a larger cost to be incurred without making a reasonable profit impossible.

America, however, presents a different picture. Petroleum and anthracite are relatively abundant and cheap. Hence the return from the products of the low-temperature process, save in exceptional circumstances, does not seem to hold out sufficient promise of profit at the present time to warrant the expense and trouble of carrying it out.

There is one fact, though, that has received little attention on this side of the water and that may result in the adoption of low-temperature carbonization long before the prices of oil and anthracite make such a practice imperative. Semi-coke or char, the solid residual fuel from the process, is more reactive in combustion than other available solid fuels. As a consequence, more of this fuel can be burned per square foot of grate area per hour than is the case with most of the other available fuels. Resulting boiler economies may work strongly for the development of low-temperature plants long before they could otherwise be successfully installed.

Too Many Boiler Test Codes

THE purpose of any test code is to provide a standard method for testing the particular equipment under consideration. What, then, is to be done when two societies publish codes for testing the same equipment? Unless by some happy chance, the codes are alike in all essential points, there will exist two standard methods of testing and the question immediately arises, "Which code shall be followed?" The resulting confusion is obvious.

Recently, the American Society of Heating and Ventilating Engineers approved a revised edition of its code for testing low-pressure steam-heating boilers fired with solid fuel. At about the same time the National Boiler and Radiator Manufacturers' Association also adopted a code for testing steam-heating boilers. While these codes are fundamentally similar, they nevertheless, contain important differences.

For example, the A.S.H. & V.E. code states that tests shall be continued until one hundred and forty pounds of fuel per square foot of grate area has been fired, while the other code provides that two hundred and fifty pounds of fuel shall be fired per square foot of grate before the test is complete. Somewhat different instructions are given in the two codes regarding the manner of starting and stopping tests. These are differences that tend to make comparisons of tests made according to the two codes difficult and perhaps meaningless.

It may also be observed that little advantage seems to have been taken of the more complete boiler test code published by the A.S.M.E. This code has long been established, and many of its provisions apply to testing heating boilers.

Not only would considerable time and expense have been saved had these organizations co-operated and adopted the same code, but also much of the confusion that may now exist would have been avoided. It is hoped that these organizations may find a way to eliminate the differences in the codes in the near future.

Earn While They Learn

SINCE Dr. Harvey Davis assumed the presidency of Stevens Institute of Technology, attention has focused on that school in expectation that things would happen. They have.

At the outset, in his inaugural address, Doctor Davis came out strongly for a more liberal curriculum in engineering, with less specialization—a policy that is coming into favor among the more progressive universities.

Next, it was announced that the total student enrollment would be limited to five hundred, on the theory that better work could be accomplished with small classes.

Now comes a novel and more radical announcement—one that has not been tried out before, but which other institutions might well consider. It concerns tuition. In most colleges the tuition is insufficient to meet the cost of instruction, the difference being made up through endowments. But under the usual plan of a fixed tuition fee these endowments benefit all alike, the rich, the poor, the industrious and the indifferent student.

The plan announced for Stevens carries what is equivalent to a sliding scale in tuition that places a premium upon scholastic standing. There is a base fee, slightly higher than heretofore, which is applicable to all and against which rebates of various amounts are made in accordance with the student's proficiency in studies and activities outside the classroom. It will be possible for one hundred and sixty-two students to participate in these rebates, which vary in amounts from fifty to six hundred dollars a year. Thus it would be possible for a student who stands at the top of the list each year to get a 2,400-dollar four-year college course for three hundred dollars. Others would pay anywhere from three hundred fifty up to the full tuition.

Inasmuch as the plan is open to all, there is no discrimination as to the student's financial standing. It does, however, make it possible for the student of limited means, but possessing initiative and ability, to attain an education without having to resort to outside employment, as is so often necessary. Those hours that might have to be spent in such employment can now go toward making him a better engineer and preparing him for leadership.

Aside from the advantages to the students, the college will actually come out ahead by about forty thousand dollars a year, because of the increase in the base rate. Furthermore, those making endowments will have the satisfaction of knowing that their aid is being extended to those most deserving and to promote better scholastic standing.

The plan is an experiment along constructive lines and Doctor Davis is to be congratulated on putting it into effect. Engineers and educators will watch its application with keen interest. If the results are as anticipated, it will probably find wider application.

They Trust the Engineer To Do the Job

A BRIDGE is wanted to span a great river; business men and politicians decide to have it (after consulting the engineer) and the engineer does the job. Often his name gets on the dedication tablet—near the bottom. A tunnel under a river or through a mountain range would simplify traffic or save miles of climb for panting locomotives; an engineer is consulted—and does the job. Rule-of-thumb traffic regulation gets into a tangle; as a last resort the engineer is called in and solves the problem. Hit-or-miss management finds itself swamped with high manufacturing costs. The engineer takes the wheel and reduces production costs so far that only distribution—still unengineered—stands in the way of low prices to the consumer. More efficient power plants are needed. The engineer is ready for the call, makes new specifications and delivers the goods. So it goes with activities where natural forces are harnessed.

Yet so quietly has the engineer done his work in the past that he has been taken for granted. Since he has rarely failed, the public has not thought him worth much thought. But that attitude is changing. Engineers have edged into the limelight and the average man has begun to grasp the fact that the superlative permanence of the engineer—his habit of getting the job done right and on schedule—arises from his almost uncanny instinct for searching out facts.

Slowly but surely, the engineer is gaining the recognition he has so long and so richly deserved. And those who know him best have no fears that he will fail to meet the test. That this view is shared by the general public is evident from the frequent expression in the daily press of the conviction that America's new Chief Executive will carry the Nation to new heights by applying engineering methods to its great economic problems.

Progress in the Art of Steam Generation

Grows Out of Operating Experience

By George F. Klein
Power Engineer, A. E. Staley Manufacturing Company

SOME years ago, at the plant of the A. E. Staley Manufacturing Company, Decatur, Ill., a large manufacturer of corn products, forced-draft chain grates were installed under twelve 5,580-sq.ft. boilers for burning low-grade Illinois coals. In 1923 the boiler house was extended and plans prepared for the future installation of six 8,970-sq.ft. boilers with the same type of stokers. During 1924 two such units were installed and the building, including all boiler supporting steel, ash hoppers, coal bunker, etc., for the future four boilers, was completed. The boiler room is arranged in one aisle, expansion being possible only in one direction because of other buildings, with the result that the building is well over 400 ft. in length.

Excellent results were obtained with these stokers, the operating efficiencies having been good and stoker maintenance low. On the other hand, furnace maintenance has been unusually high. The settings for the first six boilers are 9 ft. from the bottom of the front header to the floor line, for the next six, 10 ft., and for the two larger boilers this distance has been increased to 12 ft. 6 in. Maximum loads of 25,000 lb. of steam per hour have been carried continuously by the smaller boilers and 54,000 lb. by the larger ones.

After adding the two larger boilers, plant requirements grew to such an extent as to necessitate the operation of all fourteen units continuously, allowing only short periods for making repairs. With prospects of a further increase in load, the boiler house already built and further expansion limited on account of the space available, the plant was faced with the possibility of increasing its capacity only to the extent of the provisions made in 1924. Therefore, any means of increasing the available steam-generating capacity in the present building was looked upon with favor and its installation proposed.

Fig. 1—Interior of furnace looking toward rear wall

About this time there was announced the new "Combustion Steam Generator," which offered double the amount of steam obtainable within the same floor space at increased efficiency, and it was decided to install an experimental unit. This was in 1927. Although the efficiency has been high, the expected capacity has not been attained, in spite of many alterations. The unit was designed to deliver a maximum of 150,000 lb. of steam per hour, carry a continuous load of 125,000 lb. per hour, and not occupy any more building area than that taken by the 8,970-sq.ft. stoker-

fired boiler. On this basis it would have been possible to install a total of 600,000 lb. of steam-generating capacity in the space provided for 216,000 pounds.

In the operation of the generator with low-grade Illinois coal, the primary difficulty experienced was excessive slag formation at the high B.t.u. release required to obtain high capacity. Instead of being able to operate at a release of 32,000 B.t.u. per cu.ft. of furnace volume, 25,000 B.t.u. appeared to be about all that was possible if the unit was to be kept in operation over any considerable length of time. This resulted in a capacity of 85,000 lb. of steam per hour, at which output operation was as satisfactory as could be expected with this grade of coal and size of furnace, and the efficiency ranged from 80 to 82 per cent. Even at this rating the unit produced more steam than was possible for a stoker-fired unit in the same space.

A still greater demand for process steam again necessitated additional capacity. Many studies were made of standard boilers of different types and sizes equipped with stokers and pulverized-fuel systems, but none of the various layouts would give the desired capacity in the space allotted.

Eventually, it was decided to install three more large pulverized-fuel units and convert to pulverized coal the present two 8,970-sq.ft. stoker-fired boilers. This decision led to the question as to whether the unit system of firing and milling or the central system of preparation with turbulent firing be used. Practically all existing types of installations were inspected, costs of operation and maintenance obtained, and among them plants were found using both systems of firing and preparation for low-grade Illinois coal. The figures appearing in the accompanying summary are all actual costs. Maintenance and operating costs were taken from operating records extending over a period of several years on large installations. Bids were received on the two types of systems with the results given.

Having operated one of the largest storage systems of pulverized-fuel firing in present-day use in a large central station in the Middle West, the writer had favored the central system, but the economic advantages shown in the table for unit mills left no other choice for the particular conditions existing. A boiler unit developed along the lines of this investigation is being installed and soon will be placed in operation.

Another 8,970-sq.ft. boiler of the same size and type as two others previously installed and of the same general construction as the other twelve, was chosen. The building steel and bay spacing were already arranged to handle this size of unit, but with a stoker furnace, and its adaptation to burn pulverized fuel did not involve extensive changes. The boiler is set reversed. It is built for a working pressure of 210 lb., having three drums,

AT STALEY PLANT

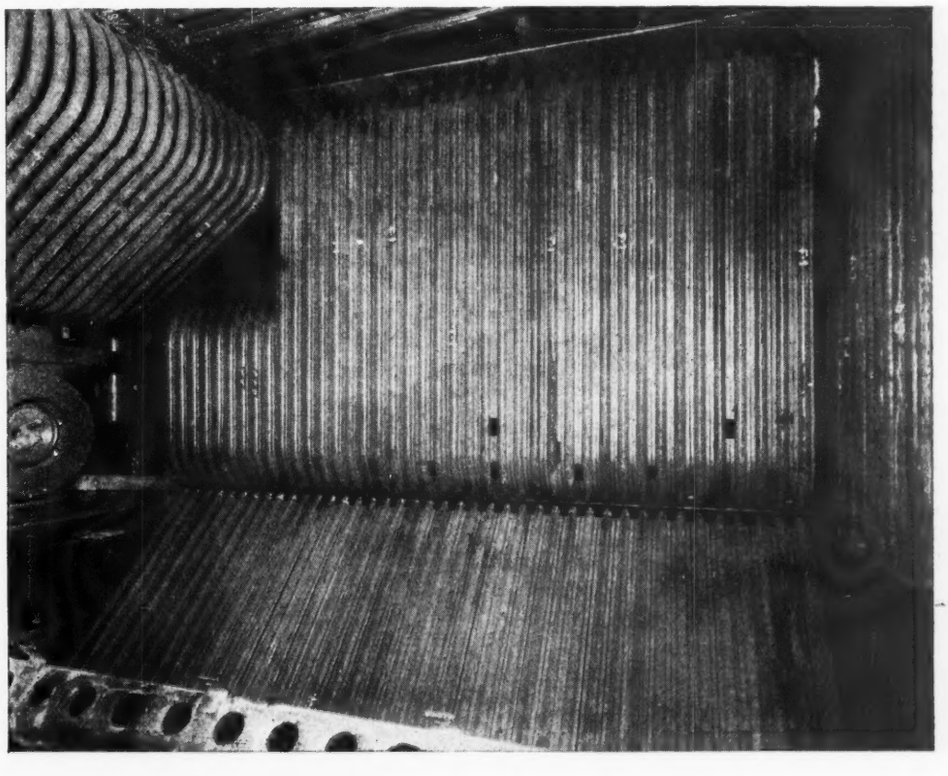


Fig. 2 — Interior of furnace, showing water-cooled surface

The holes in the side wall are for the purpose of removing slag from the fin-tube V-bottom. In upper left-hand corner may be seen the tube arrangement in the drop bank to form a slag screen.

21-ft. tubes and a combination horizontal and vertical baffle arrangement. Several changes were made in the tube arrangement as compared to the boilers installed in 1924. As the question of furnace volume was important, it was decided not to use a convection-type superheater. The tubes were raised on the box headers closer to the boiler drums, thus gaining the height of one tube, or about eight inches.

In the lower row of the drop bank alternate tubes have been omitted and in their place tube nipples have been rolled in both front and rear box headers, thus providing holes of ample size for the insertion of a stout bar or tool into the boiler furnace at the point of slag concentration. To prevent air infiltration metal caps of light-gage iron are sprung into the openings when not in use. It is felt that the opening up of the tube spacing at this point will give as much if not more heat absorption than with the tubes in place, as three additional tubes are exposed partly to the radiant heat of the furnace.

Another departure from the standard design of drop bank in box-header boilers is the division of the box header at the drop bank into a separate section, with tube holes for rolling nipples into it for connection with the main header. This requires the shortening of the other part of the header an amount equal to that taken up by the nipples and the separate header, so as to keep both front and back headers the same length. This construction allows for more expansion and provides a more flexible drop bank.

At 400 per cent of nominal rating the boiler is designed to deliver continuously 100,000 lb. of steam per hour. In the steam main there is provided an outside type of separator that is expected to deliver commercially dry steam at all ratings.

sign is that shown in the accompanying sectional elevations of the boiler and furnace. The slope of the V-bottom is about 50 deg., which is not so much as desired, but the most that could be had in the space available. The furnace is long and narrow, being a little over 14 ft. wide and 24 ft. long.

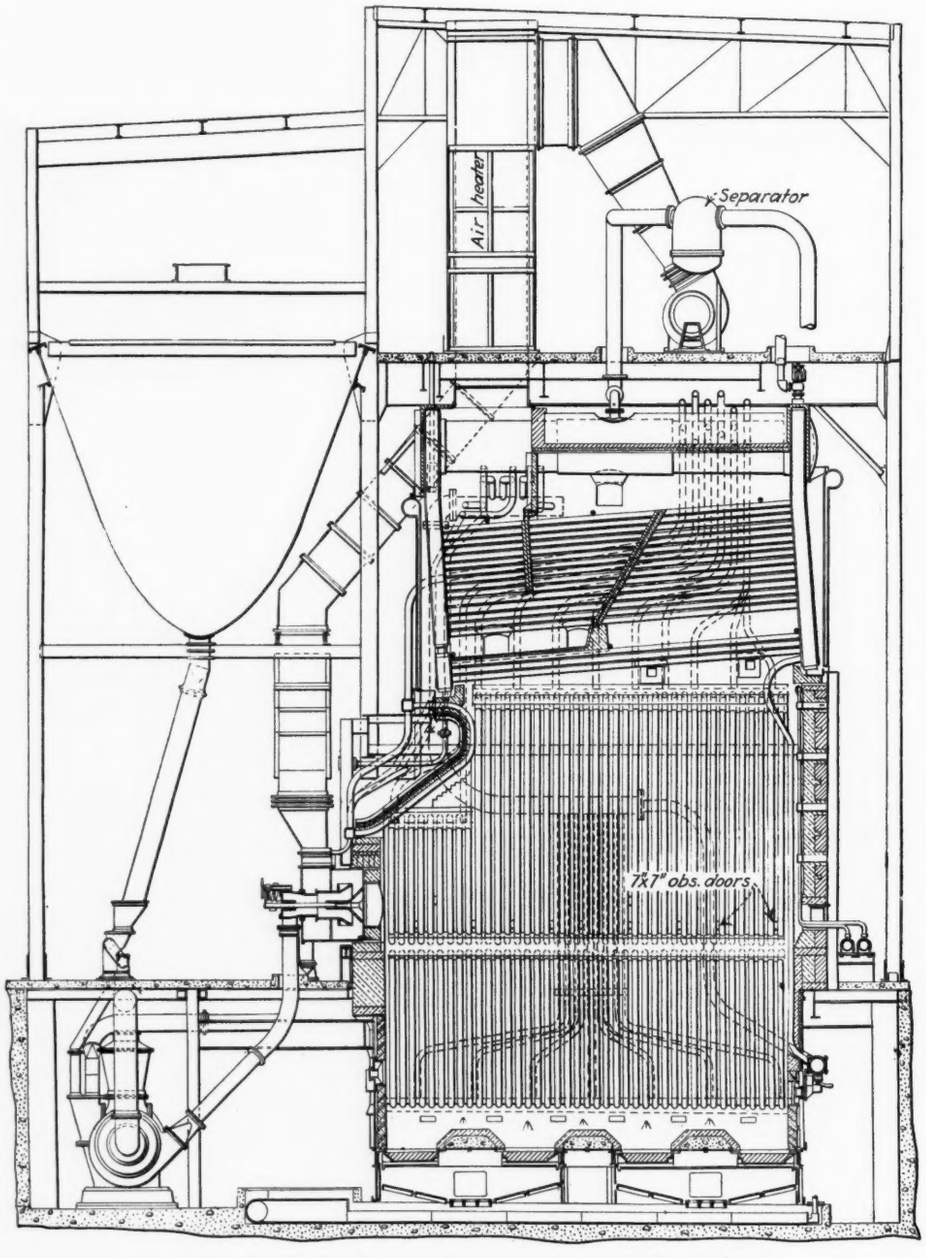


Fig. 3—Secional side elevation of new boiler unit

In the design of the boiler furnace the paramount issue was to get the utmost capacity from the boiler and at the same time hold the B.t.u. release as low as possible with the low grade of coal to be burned, so that every possible means of increasing the furnace volume was used to advantage. The boiler was raised to the limit in height until the drums were just below the building girders. This allowed for a gain of approximately five feet in height over the stoker-fired boilers. It was found also that the boiler could be set back about three feet, thus providing a sort of Dutch-oven effect for the burners and also increasing the furnace volume. The resultant de-

Differing from other V-type bottoms, the V is located the long way of the furnace. The side walls are finned tubes, a separate header being used for the shorter portion under the arch. The rear wall construction is of bare tubes on boiler-tube centers. Behind these bare tubes there is installed a radiant superheater, and means are provided for the use of tile that can be placed between the wall tubes and the superheater tubes for the purpose of regulating the superheat. The rear wall is carried below the V-bottom, so that brickwork at the rear of the furnace can be eliminated and any flame impingement will be on a water-cooled wall. However, the depth of

the furnace (24 ft.) should eliminate any possibility of slag formation here.

That part of the front wall that is not taken up with the burner casings is of brick, but there is little refractory. The arch is water cooled, a recessed tile construction being used to assist in the ignition. The close proximity of the burners to the arch seemed to make the water cooling necessary. The arch circulation is included in the circulation of the boiler proper.

The V-bottom of the furnace is unusual in that it is made of bare finned tubes without refractory or metal coverings. In the design it was felt that as cool a bottom as possible was the most desirable factor, provided the ash would not accumulate and slag formations could be readily removed. A bare tube will absorb more heat than any covered tube, but the maintenance of a smooth surface for the ash was a problem.

The necessity of keeping the fins in close contact at

COMPARATIVE INVESTMENT AND OPERATING COSTS OF PULVERIZED-COAL UNIT-MILL AND STORAGE SYSTEMS

Item	Unit System	Storage System
Investment cost*	$166,625	$334,116
Operating costs and maintenance per ton of coal burned, cents	10.91	19.29
Power costs per ton of coal burned, cents	5.40	6.60
Tons of coal burned at same efficiency (both systems) annually	300,000	300,000
Annual costs:		
Fixed charges at 17 per cent	$28,326	$56,800
Operating costs	48,930	77,670
Coal at $2.10 per ton	630,000	630,000
Total	$707,256	$764,470
Yearly saving in favor of unit mills		$57,214

*Fuel burning and preparation equipment for five units exclusive of boilers and furnaces.

all times, so as to present a smooth surface even though the fins would form a curved surface, made the problems of tube alignment and expansion of importance. Any holding device must be such that any tube can be removed and replaced without disturbing the alignment of the remaining tubes. The method of holding the tubes by welding on a lug and the use of a hook bolt is shown in Fig. 5, and the general appearance of the completed job in the photographs. The bottom tubes have an effective length of ten feet and are supported at five points, three by means of lugs and hook bolts, the other two being at the header connections. It is believed that the tube alignment will be positive at all times, and that the bottom will give entire satisfaction.

Should difficulty be experienced because slag does not run freely from the finned-tube bottom, holes provided on each side of the vertical water wall just above the junction box with the bottom tubes will permit insertion of an iron bar or other tool into the furnace to help the slag toward the ashpit. In the drawings and photographs these holes can be seen at the operating floor level, where they are readily accessible. They are spaced as closely as practicable without interference from the circulating piping from the water walls. Owing to the shortness of the bottom tubes this method of cleaning should be effective.

Immediately below the bottom is attached the ash hopper, which is a part of a hydraulic ash-sluicing system. These hoppers and the sluiceway were made as large as the space conditions would permit. A throat of ample width has been provided, so that, through clean-out doors in the ash hopper, it is possible to operate a bar into the V-bottom to assist in slag removal. Thus, with means on the furnace operating floor and at the ashpit to remove slag from the 10-ft. tubes, there should be little difficulty in removing slag from the bottom.

Water circulation was given special consideration in the design. Instead of bringing the upcomers into a common header and using large openings into the drums and thus weakening them, all upcomers were brought to the boiler drums full tube size. This made necessary many small tube openings into the drums, but the method materially aids in steam liberation and circulation. It will be noticed that the rear water tubes are connected

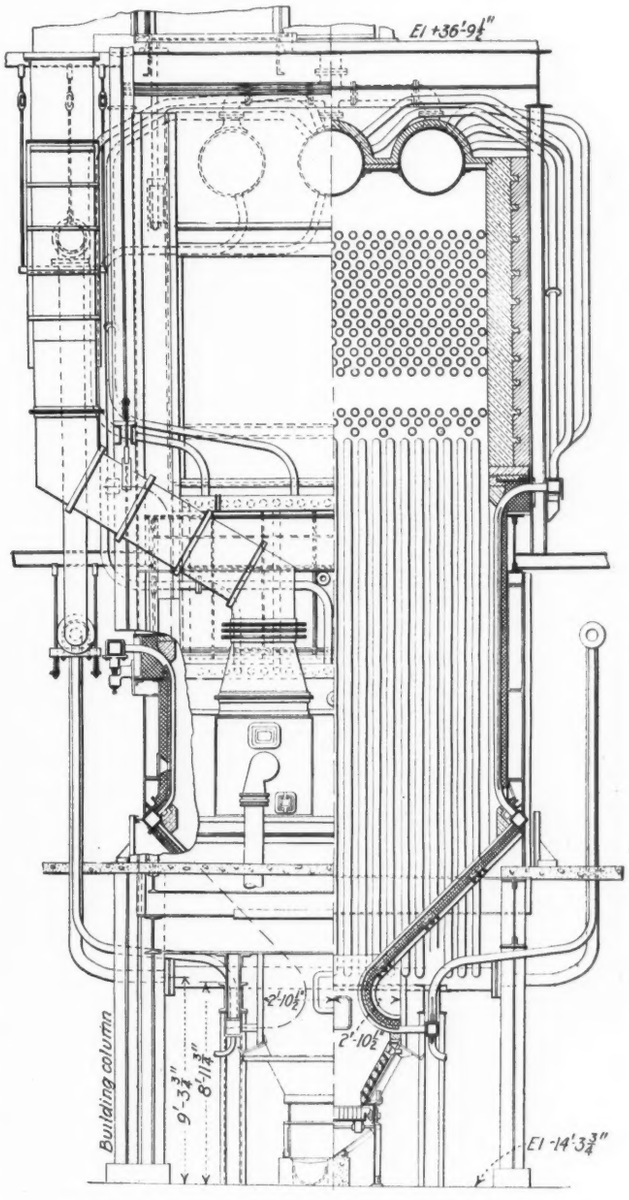


Fig. 4—Front elevation of boiler in part section

directly into the bottom of the rear box header of the boiler. As the rear water wall was on the same tube centers as the boiler tubes, the standard box header was used and the circulation problem simplified inasmuch as a large header and large upcomers were eliminated. All circulation is so balanced that each of the three drums of the boiler has approximately the same number of connections.

For the sake of simplicity in erection, maintenance and cleaning, as well as to obviate the necessity of large unwieldy fans, two air preheaters are used, each with a separate induced-draft fan, but both receiving their

air from a common forced-draft fan. Doors opening to the gas passages of the envelopes are provided, so that a lance for cleaning can be used from a convenient operating level. The preheaters are set immediately above the boiler uptake, thus providing an unrestricted straight passage for the flue gases to the suction of the induced-draft fans. This arrangement also limits the draft loss in the preheaters. The preheater has $\frac{3}{4}$-in. gas spacing and $\frac{1}{2}$-in. air spacing. Dampers are placed so that it is possible to operate one preheater in case of trouble with the others, although regular operation contemplates the operation of both units at all times when the boiler is in service. The ducts are arranged to bring preheated air to the burners and the unit pulverizers.

Grinding and pulverizing low-grade Illinois coals without excessive maintenance and power consumption is a problem. There are few outstanding installations having low operating costs with this grade of coal. In fact, to

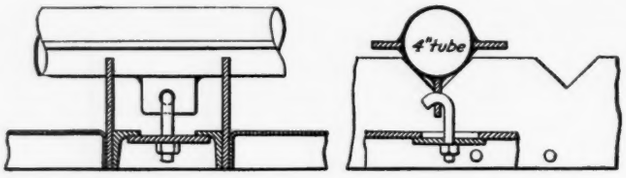


Fig. 5—Method of supporting and clamping fin tubes forming V-bottom of furnace

the writer's knowledge, only two types of unit mill had been used enough in this district at that time to give sufficient operating data to form the basis for a choice.

The burner and mill arrangement was designed so that a unit of each type could be used under the same boiler and at the same time. In this way it is expected to gather comparative operating data. Each mill is provided with a burner of a type specially suited to the mill, and both mills represent the latest development of each manufacturer. Instruments and means have been provided for measuring the coal, power, etc., to each unit, and running logs prepared so that complete information will be available and more light brought out on the question of pulverizing low-grade Illinois coals.

To regulate the operation of the boiler and pulverizers, a complete control board has been provided. The instruments consist of a six-pen recording pyrometer for preheater performance, a boiler meter for steam-air flow, recorders for preheat to the mills, a recorder for steam temperature and pressure and a ten-pointer indicating draft gage. An electrical control panel, mounted in the center of the group, contains start and stop buttons, and ammeters for all motors and emergency stations. The entire system is started and stopped from this central control panel and certain interlocks have been provided for "foolproof" operation.

Power for operating the control apparatus is supplied at 440 volts from a separate transformer, whereas the motors are all wound for 2,200 volts. All the control apparatus is so interlocked that the forced-draft fan and the two pulverizers cannot be started unless one of the induced-draft fans is running. Neither induced-draft fan can be started unless all three fan motors have the drum controllers in the off position. Neither pulverizer unit can be started unless the forced-draft fan is in operation. The push-button stations on the central control panel for all three fan motors are so wired that pushing the start button of any one of the three will start the three motors simultaneously, provided the controllers are in the off position. The pulverizer units can then be started by means of their respective push buttons. In the control circuit for the induced-draft fans a selective knife switch insures the same cycle of control in case either or both fans are in service.

Pushing the stop button of any fan motor will immediately shut down the one or two pulverizers that are in operation and the forced-draft fan next, but the induced-draft fan will remain in operation for the length of time set by an adjustable time-delay relay. Either pulverizer unit can be started or stopped at any time the fans are running without affecting the other equipment, but if for some reason both pulverizer units are stopped the fans will stop in the sequence previously mentioned. Pushing the emergency-stop buttons shuts down everything without any delay for the induced-draft fans.

Reasons for this type of control are obvious. Pulverizers should never be run and discharge coal into the furnace unless it is being burned or a fan is running to withdraw the gases from the furnace immediately. The shutting-down sequence is used to give the induced-draft fan time to clear the furnace of all combustible gases, so as to minimize the possibility of an explosion when starting up. The control apparatus is located at the motors in dust-tight steel cabinets.

PRINCIPAL DATA ON NEW BOILER UNIT

Coal.....Illinois, Springfield District
Fixed carbon, 46.11; volatile, 37.93; ash, 16.17; moisture, 14.36; sulphur, 4.77; B.t.u. dry, 11,650; B.t.u. as received, 9,962; fusion temperature of ash, 1,875 deg. F.

Boiler.....Edge Moor Iron Co.
Normal heating surface, 8,970 sq.ft.; 21-ft. tubes, 18 high and 22 wide; 3 drums; combination horizontal and vertical baffles; 3-pass; drop bank, 3 tubes high; upper bank, 15 tubes high; working pressure, 210 lb. gage; capacity, 100,000 lb. of steam per hour; Hagan outside type separator.

Furnace.....Combustion Engineering Corp.
Combination fin and plain tubes, V-type bottom, water cooled arch, horizontal firing of pulverized fuel. All water wall tubes, No. 6 gage; surface in equare feet:

Hopper bottom, fin tubes	608
Side wall, fin tubes	692
Rear wall, plain tubes	500
Arch, plain tubes	250
Total water-wall heating surface	2,050

Furnace—14 ft. 9 in. wide, 24 ft. 3 in. deep; furnace volume, 7,000 cu.ft.
B.t.u. release at 100,000 lb. of steam per hour, 19,500
B.t.u. release at 85,000 lb. of steam per hour, 16,000
Guaranteed efficiency, 82 per cent at 100,000 lb.

Mills and burners.....Combustion Engineering Corp. (Furnace Engineering Co.)
One Lopulco Raymond unit mill, 8,000 lb. per hr., and one 30-in. Couch adjustable type C burner.

One Simplex mill, 8,000 lb. per hour, and one 30-in. Simplex burner.

Preheaters.....Combustion Engineering Corp.
Two-plate type, $\frac{1}{2}$-in. air spacing, $\frac{3}{4}$-in. gas spacing; 33 elements per heater, each element 18 ft. high and 6 ft. wide; total area, 7,128 sq.ft.

Performance at 100,000 lb. of steam: Gas entering heater, 635 deg. F.; gas leaving heater 387 deg. F.; air entering heater, 70 deg. F.; air leaving heater, 468 deg. F.

Fans.....Bayley Manufacturing Co.
One 32,000-c.f.m. against 10.5 in. w.g. for induced draft.
Two 45,000-c.f.m. against 8 in. w.g. for induced draft.

Motors and electrical control.....General Electric Co.
Two 125-hp., 2,200-v., 1,200 r.p.m. for pulverizers.
Two 125-hp., 2,200-v., 450/900 r.p.m. for induced draft.
One 100-hp., 2,200-v., 600/1,200 r.p.m. for forced draft.

Soot blowers.....Diamond Power Specialty Co.

Ash handling.....Allen-Sherman-Hoff Co.

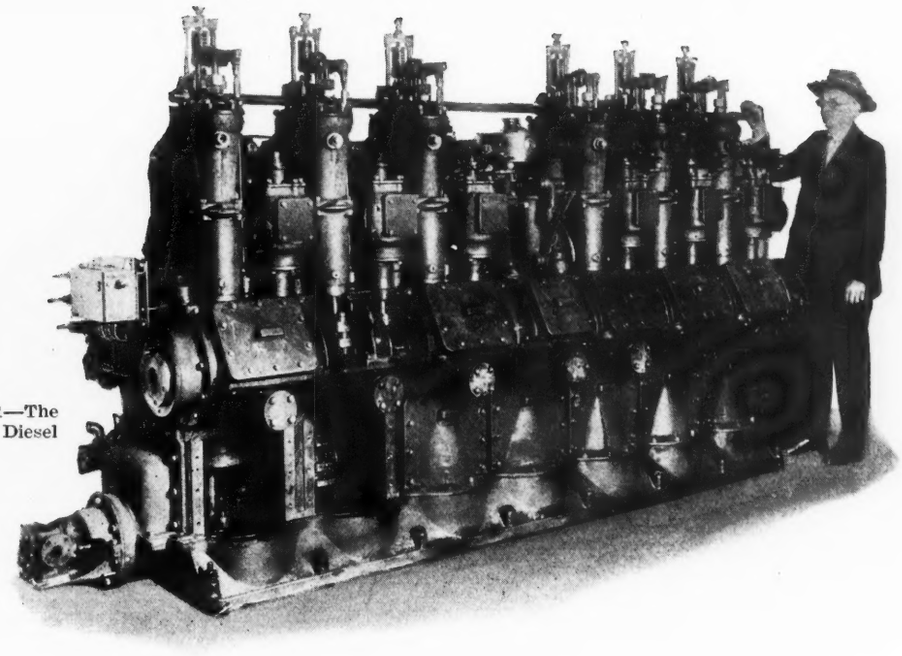


Fig. 1—The McCarty Diesel

A Diesel Engine Uses Hot Air for Fuel Injection

By Norman McCarty
Consulting Engineer, Clinton, Iowa

A HIGH-SPEED two-stroke-cycle Diesel has been developed by me at the plant of the Climax Engineering Company, Clinton, Iowa. This unit has one important feature heretofore unemployed in American engines—hot air instead of cold air or pump pressure for the injection of the fuel. It possesses other distinguishing features, the most important of which is the method of shifting the timing of the rotary scavenging valve. This permits the compression pressure to be high when starting cold and lower when the regular engine speed is reached, thereby always obtaining a suitable final compression temperature.

The engine shown in Fig. 1 has six single-acting cylinders, of 7½-in. bore and 10-in. stroke. At 600 r.p.m. each cylinder delivers 50 b.hp., with an indicated m.e.p. of 112.5 lb., or a brake m.e.p. of 75 lb. Under this load the fuel consumption is 0.47 lb. per brake-horsepower-hour.

No special material is used in its construction; the framing and cylinders are of cast iron. The one unit so far built weighs 40 lb. per b.hp., but this could easily be reduced to 35 pounds.

A cross-section of the air-injection compressor and the working cylinder appears in Fig. 5. A small amount of air at 215 lb. gage is delivered by an independent air compressor to the suction line *A* of the engine injection air pump *B*, of which there is one for each working cylinder. The air is compressed to a pressure around 1,100 lb. and forced into the fuel-valve cavity while in a highly heated condition.

During the suction stroke of the air pump the fuel pump delivers a charge of oil into the fuel valve against the 215-lb. air pressure. This relieves the pump of some of the work involved in handling oil against the usual 1,000-lb. air pressure. During the compression stroke of the air pump the air pressure and temperature are raised so that by the time the fuel needle valve is lifted, the air has become highly heated. A diagram from the air pump is shown in Fig. 2. The fuel needle valve opens when the compressor crank is 35 deg. from top dead center and remains open until the compressor piston has reached the end of its stroke. This is brought about by having the engine crank lead the compressor crank by 35 deg. F.

During the fuel-injection period the injection air pressure continues to use from 1,100 lb. to a final value of 1,300 pounds.

When the piston uncovers the exhaust ports, most of the burnt gases escape before the rotation of the scavenging valve *F*, Fig. 6, permits the scavenging air to flow from the manifold connection *T* to the scavenging ports.

A weak-spring diagram, Fig. 3, shows the events at the end of the stroke, while Fig. 4 is a 90-deg. diagram from the working cylinder.

After the exhaust ports are covered on the next compression stroke, the valve F permits the scavenging air flow to continue until the scavenging ports are closed. By this time the cylinder pressure equals that of the receiver, giving a supercharging pressure of 6 lb. gage.

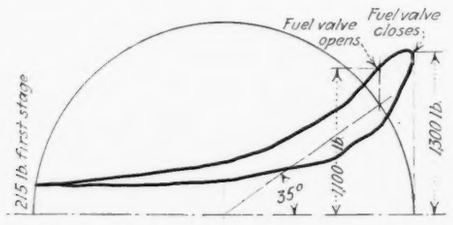


Fig. 2—Diagram from the air pump

The chief advantage of the controlled scavenging is that with a two-stroke-cycle engine the time interval during which the exhaust ports are uncovered is greater at slow speed than at high, and as the air lost per stroke through the exhaust is in the same proportion, the compression will vary with the speed and finally will reach a

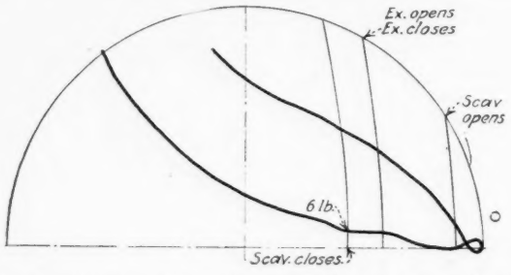


Fig. 3—Weak-spring diagram of working cylinder

point where an ignition temperature will not be obtained.

When such an engine is started, the scavenging air is cold, which tends to lower the final compression temperature. By shifting the scavenging valve F, the final temperature can be brought up to the ignition point without too high a final pressure. At high speeds the valve,

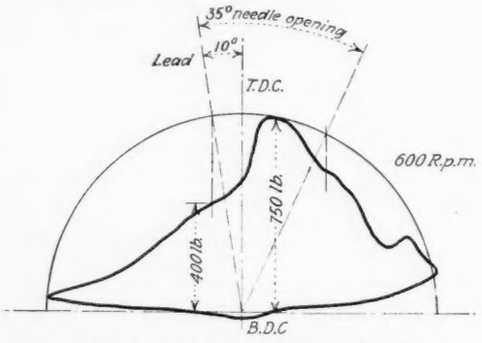


Fig. 4—A 90-deg. offset diagram

through a rotation of the valve sleeve R, gives full supercharging.

The scavenging air is supplied by the step piston H, which makes it necessary to build the engine in multiples of two cylinders. This air is drawn in through the valve W and is discharged through V into the receiver.

The system of injection used on this engine has the additional advantage that, as there is no cooling effect from the injection air, the cylinder compression can be kept as low as with solid injection, and all fouling of the injection mechanism is prevented by the volume of highly heated air passing through with the oil.

An additional advantage is that the builder can deliver, at the request of the customer, a mechanical-injection engine by eliminating the first-stage compressor and using the second-stage compressor as a single-stage unit to furnish a small volume of hot air at medium pressure to clean out the drip, which is one source of trouble with solid-injection engines. It would only be necessary to change the fuel valve and fuel pump.

The design gives the greatest horsepower output at the least cost. It gives all the advantages of cold air and mechanical injection, while eliminating all features recognized as objectionable, resulting in more continuous operation with less expense for servicing.

An engine of this type will deliver 70 per cent more power than a four-stroke-cycle engine, or 50 per cent more power than a two-stroke-cycle crankcase-compression engine of the same piston displacement, with practically the same construction cost per pound.

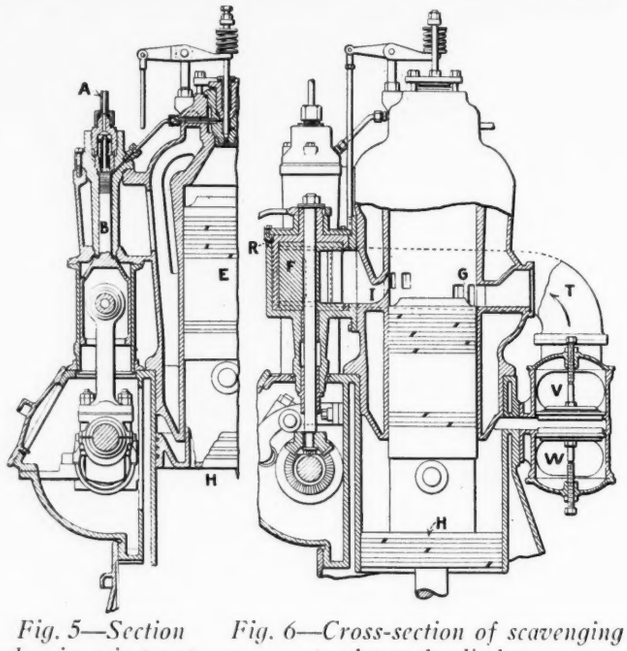
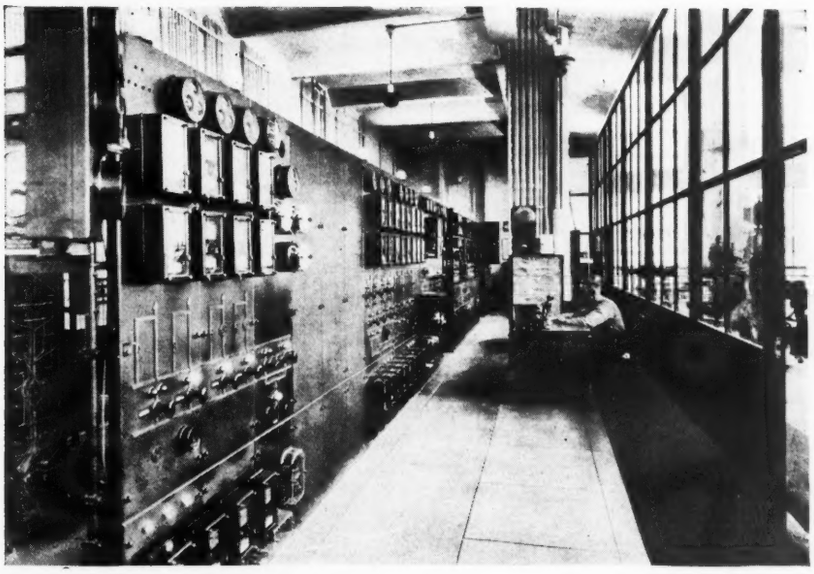


Fig. 5—Section showing air pump

Fig. 6—Cross-section of scavenging valve and cylinder

The thermal efficiency of the high-speed internal-combustion engine, according to H. R. Ricardo, increases, within limits, as the diameter of the cylinder is reduced; for, with regard to heat-loss, the higher ratio of surface to volume is compensated for by the increase of speed, while the smaller cylinder permits the use of a higher compression ratio. In the light of present knowledge the highest thermal efficiency is obtained in gas engines when the cylinder is between three and six inches in diameter. The highest thermal efficiency ever recorded by any heat engine (39.5 per cent on the net horsepower) was obtained on a Napier racing aero-engine. The highest thermal efficiency ever recorded on a gas engine using town gas was obtained by A. F. Burstall at Cambridge University, on a high-speed variable-compression engine of only $4\frac{1}{2}$-in. bore. Almost, if not quite, the highest thermal efficiency ever yet recorded on a Diesel engine (38.8 per cent on the net horsepower) was obtained on a high-speed Diesel of 8-in. bore running at 1,000.



Switchboard in control room of large hydro-electric plant

Control Circuits for Power Stations

include many arrangements for the remote control of oil-circuit-breaker operation. Voltages used on these circuits are given, different types of circuits are described and how to lay them out is explained

By S. Q. Hayes

General Engineer
Westinghouse Electric & Manufacturing Company

MANY different arrangements of control circuits have been developed for oil switches, to simplify connections and to provide electrical interlocks of various kinds. In practically all cases direct current, either 110 to 125 or 220 to 250 volts, is considered preferable for the main closing and tripping circuit of oil circuit breakers or similar devices. These normally employ solenoids, which, besides being of simple construction, are reliable in operation. Modifications, however, are readily possible using alternating-current control where motor operating mechanisms are utilized with circuit breakers or other devices.

These arrangements of control circuits require use of different numbers of wires running from the control switch on the switchboard to the electrically operated breaker or similar device wherever it may be. Whether the direct-current control circuit is also used to operate the indicating lamps or alternating current or some separate direct-current source is used for this purpose, influences the number of wires required. The connections are also subject to modification depending on whether a separate control bus is located near the breaker or the control energy for the breaker actually passes through the control switch on the switchboard.

Diagrams included in this article show some of the more common control-wiring connections. These are based on the use of a drum-type control switch, Fig. 1.

In Fig. 2 the diagrams show simple control circuits where the control switch performs the same function as a single-pole double-throw switch with the positive lead connected to the hinge jaw. When the controller is turned to the closed position, the current flows from the positive control bus *P*, through the upper stationary contacts 1 and 2, through the operating coil of the control relay and to the negative bus *N*. Energizing the relay's operating coil causes its contact to close. Then current will flow from the positive

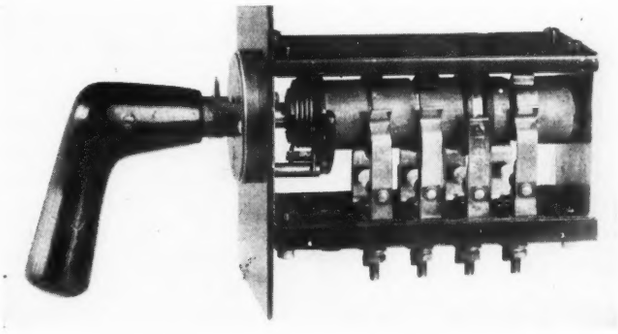
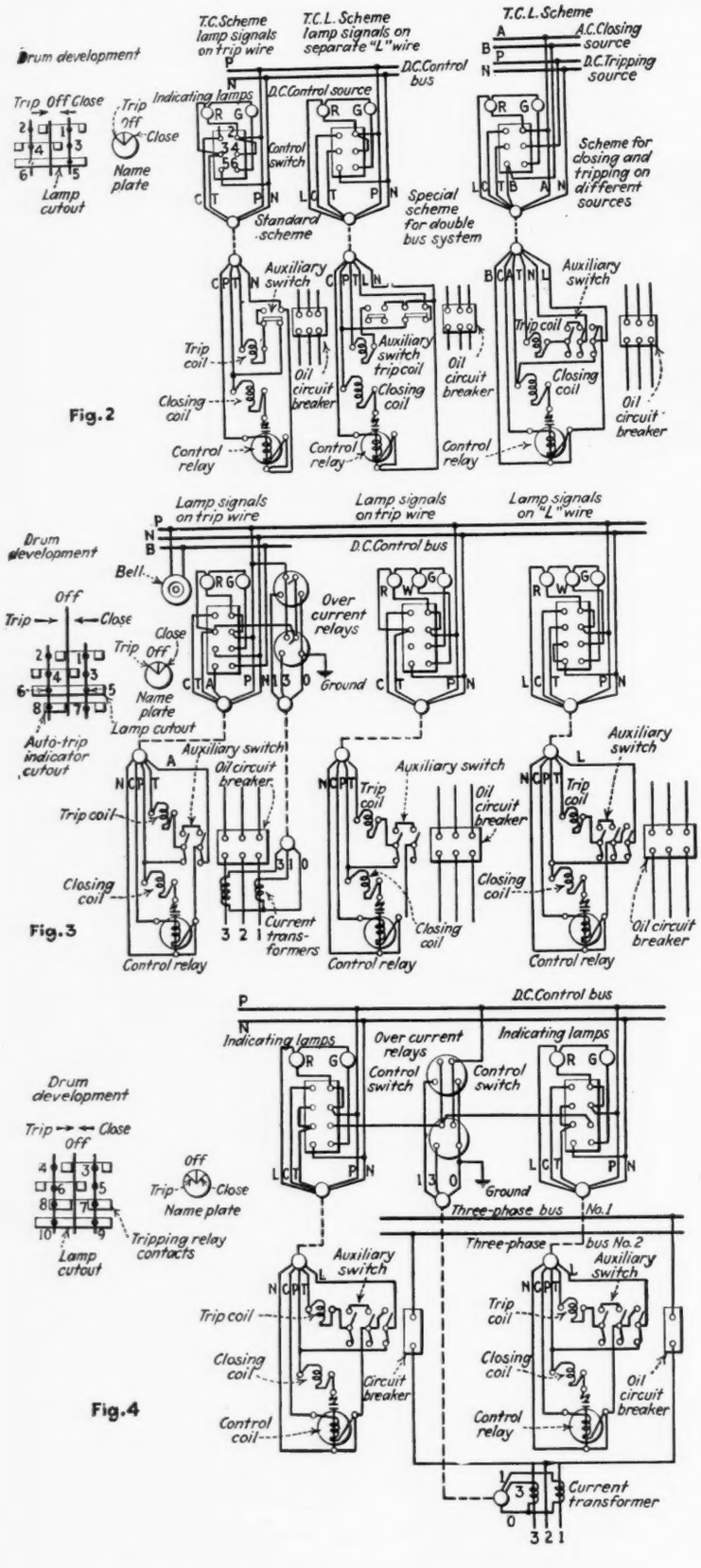


Fig. 1—Drum-type control switch



Figs. 2 to 4—Common arrangements of control circuits used for remote operation of oil circuit breakers

Fig. 2—Diagrams of simple control circuits where the control switch performs the same function as a single-pole double-throw switch with the positive lead connected to the hinged jaw. Fig. 3—In this diagram provisions are made for automatic tripping and for a bell alarm. Fig. 4—Modification of Fig. 3 for use on a double-bus system

control bus through the closing coil of the breaker, the contact of the control relay back to the negative bus.

When its handle is released, the control switch returns to its off position, opening the relay coil circuit, which then opens its main contact and cuts the current off the closing coil. Closing the breaker causes the auxiliary switch, indicated as a two-way push button, to close in its upper position. To trip the breaker, the control switch is moved in the trip position and current flows from the positive control bus P through the movable trip contacts 3 and 4 of the controller, the trip coil of the breaker, the auxiliary switch, back to the negative bus.

When the breaker opens, it causes the auxiliary switch to throw over. The latter operation opens the trip circuit so that the control-switch contacts do not have to open the inductive trip-coil circuit. The old single-pole double-throw knife-type control switch has connected similarly to the arrangement, Fig. 2, with an independent lamp signal circuit. The push-button or pull-button control also used similar connections, a suitable lamp indication being given.

Automatic Tripping Control

Fig. 3 shows a slightly more complicated oil-switch control connection to provide automatic tripping, and the operation of an alarm bell. It will be noted that the red and the green indicating lamps are connected in series across from the positive to the negative bus. The common junction point, however, between the red and the green lamps is arranged so that in the open position of the breaker, the common lead is connected to the positive bus. This shunts out the red lamp and puts full voltage on the green lamp. When the breaker is closed, the auxiliary switch is thrown to the upper position. The common connection of the two lamps is then made to the negative bus, thus shunting out the green light and putting full voltage on the red light.

As may be noted from the figure, the auxiliary switch performs two functions: One is to open up the trip circuit as the breaker comes out; the other, to transfer the lamp signals. The double push button of the old design or the later double pull button utilized similar connections. These, however, usually made no provision for the lamp cutout, although a separate single-pole knife switch or plug switch could be used to obtain this feature.

Fig. 4 is a modification of Fig. 3 for use on a double-bus system. Connections are so made that either circuit breaker can be closed or tripped by its control switch independent of the other. The one set of current transformers and relays will trip out either or both oil circuit breakers that may be closed.

Multiple-Conductor Cable Used

Diagrams of the type shown with various individual wires can be followed out easily. When the breaker is indicated with its protective relays, current transformers, etc., the wiring cannot be followed out so readily. In complicated switchboard diagrams, instead of showing the individual wires running in each circuit, it is customary to combine them into two-wire, three-wire, four-wire or other multiple-conductor cables. Such a diagram is also used to advantage in preparing a conduit layout, as it indicates by a single line the multiple conductor cable. Each end of a typical cable is usually shown with the individual wires spread out and connected at one end to the controller and indicating lamps and at the other end to the breaker or other apparatus controlled.

Fig. 5 is a diagram of an oil circuit breaker control

arrangements using trip-free relays and separately mounted knife-type auxiliary switch. This diagram shows the oil circuit breaker, the current transformers and the overload relays. Usually, on an actual diagram of a large installation the connections from the current transformers to the overload relays would be indicated as run in a three-conductor cable. On this diagram the individual wires have been run from the current transformers to the relays.

From the control switch, however, to the circuit breaker a three-conductor cable is indicated with the leads at each end of the cable marked with the letters *L* for lamp, *T* for trip, *C* for close. For this type of control three-conductor cable would be utilized. Such an arrangement is feasible if a direct-current control bus is located near the breaker as well as on the control board. If there are only a few breakers and these are scattered and of such size that the control switch can readily handle the closing circuit directly instead of through the contactor switch, four-conductor control

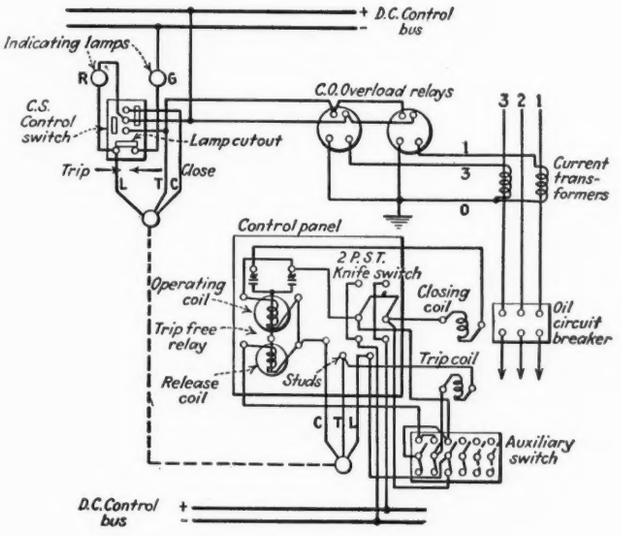


Fig. 5—Diagram of an oil-circuit breaker control arrangement using trip-free relays and knife-type auxiliary switches

wiring would be needed. The closing lead would be made larger than the trip or lighting leads. A lead of the same size as the closing lead would be used as a return circuit.

Modifications in the control connection permit the use of a duplex cable instead of a three-wire cable. In this case one lead is the closing circuit and the other the tripping circuit lead with the signal lamps operated through the trip circuit leads.

Where the distance between the circuit breaker and the control point is relatively great, a special arrangement of connection permits a single wire to be used. This method employs hesitating relays and obtains the necessary control and signaling by arranging to connect this lead either to the positive or to the negative source of supply.

Other methods, employed chiefly for supervisory control, enable almost any number of circuits to be controlled over a few pairs of telephone leads without interfering with the use of these lines for telephone communication purposes.

Causes of Noisy Operation of Induction Motor

By W. E. Warner

NOISY operation is a trouble experienced with induction motors. Noises made by induction motors can be divided into two classes—those due to mechanical causes and those that have electrical and magnetic sources. The two classes can be identified by running the motor at full speed and then switching off the current. Noise due to electrical and magnetic causes will cease when the current is cut out of the machine, and any noise then made will be from mechanical causes. The latter may be produced by mechanical vibration, by loose rotating part, loose rotor bearings, or by windage, the noise produced as the air is drawn through the ventilating ducts into the motor.

Noise due to windage may be disagreeable but it is mechanically harmless. When air is drawn into a motor at a high velocity through narrow openings, there is always more or less noise, which may be increased if the ducts become obstructed with dust and dirt. Sounds produced by mechanical vibration should have their causes located and remedied. If this is not done, a breakdown in the windings may occur. Noise may also be due to the rotor-core laminations being loose.

Vibration due to electrical causes may be produced by an unbalanced rotor circuit. This usually results from joints of unequal resistance in the rotor winding, causing unequal currents to circulate through the rotor coils. Defective joints in the rotor winding will be found to have higher temperatures than the others and should be remade. An unbalanced stator circuit will also produce vibration. In a slip-ring motor the rotor circuit may be out of balance electrically, owing to the conditions of the connections to the slip rings, and the brushes. On some designs the brushes are cut out of circuit when the motor is up to speed, but in others they are not. High-resistance connections or badly fitted brushes may cause noisy operation by increasing the resistance in the rotor circuits.

Misleading Test Results Obtained With a Magneto

MAGNETOS are used extensively for testing electrical equipment and circuits for faults. It is possible for a magneto to indicate a dead ground when the circuits are well insulated.

A high-resistance magneto will ring through a comparatively high insulation resistance and this may lead to wrong conclusions. Then again, if a magneto is used to test a large machine or a long cable, it may ring when the insulation is in good condition. In this case the equipment acts as a condenser. The magneto generates an alternating voltage and charges the equipment first in one direction and then in the other, just the same as when connected to the terminals of a static condenser. This charging current for large machines is sufficient to ring the magneto's bell. Another case where misleading results may be obtained is when a magneto is used on a circuit of high inductance. The inductance of the circuit may prevent sufficient current flowing to ring the magneto and thus give the indication of an open when the circuit is complete.

You Get Something for Almost Nothing

...By Developing

POWER FROM PROCESS STEAM

By L. H. Morrison
Associate Editor, Power

WASTE in industry, so a national committee of engineers declares, is due in 75 per cent of the cases to management and in 25 per cent to the workman. One particular glaring waste is due exclusively to management—this loss lies in the failure to develop power from process steam.

At one time Colorado Springs developed all its power from a coal-burning plant. When a municipal water supply was obtained up in the mountains, advantage was taken of the high head to interpose a waterwheel in the delivery line. The water, before reaching the consumer now has part of its energy converted into electric power. This, so many will exclaim, calls for no praise of the engineer, for it was the natural thing to do.

But what about the thousands of factories that take live steam out of the boilers for process work without first passing this steam through a turbine or engine? The power so generated can be obtained at almost 100 per cent efficiency, in contrast to that from the customary condensing machine, which wastes as much as 80 per cent of the heat through discharging the steam into a condenser.

By passing all or a part of the steam through an engine, the combined cost of the process steam and power is materially reduced. True, many factories generate steam at a low pressure, just sufficient for the processes. But in the majority of cases the boilers were originally built for pressures ranging from 125 to 200 lb. Under such conditions the interposing of an engine brings up no difficulties, since the engine acts as a pressure-reducing medium, eliminating the need for a pressure-reducing valve. When the pressure-reducing valves are located in the processing departments, the mains are smaller than would be needed if low-pressure steam were fed from an engine, but the cost of the enlarged pipe line would not be great.

The point has been raised at times that little power can be developed unless the boiler pressure is raised, if a back pressure is to be maintained sufficiently high to meet process requirements. Of course, with any given back pressure, the higher the boiler pressure the greater will be the power generated; but by adding superheaters to the boilers, a considerable power can be developed with but moderate boiler pressure, as will be seen from an examination of Fig. 1, which shows the horsepower that a perfect engine would develop with a flow of 1,000 lb. of steam per hour. The horsepower an actual engine or turbine would deliver depends, of course, upon the type and design of the machine. Fig. 2 shows a set of curves that apply quite closely to what a uniflow engine will deliver.

With even 125 lb. gage boiler pressure, as much as 44 hp. can be developed from 1,000 lb. of steam if the steam is initially superheated 200 deg. F. and exhausts at 15 lb. gage. With the same initial conditions, but with a back pressure of 45 lb. gage, 18 hp. can be developed from 1,000 lb. of steam.

Development of mechanical work robs the steam of but little of its heat, the heat equivalent of a horsepower-hour being 2,545 heat units. Of the heat contained in 1,000 lb. of steam at 125 lb. gage pressure and 200 deg. F. superheat, there is left in the exhaust steam a total of 1,298,000 — 45,810 = 1,252,190 B.t.u. after generating 18 horsepower.

Of course the heat transformed into work in the engine is not obtained for nothing. A slightly greater amount of coal must be burned to give the additional amount of heat, but if the boilers were evaporating as low as eight pounds of water per pound of coal, not as much as five pounds more coal would be burned an hour to develop the 18 hp. The power is obtained at a rate of less than one-third pound of coal per horsepower-hour, which is less than one-half the amount required by the most efficient central station and about one-fourth that used by the average condensing turbine plant. In other words, power is being obtained at a fuel cost that cannot be approached by any plant generating power.

If power is purchased or developed from steam supplied by other boilers, fixed charges on the additional boilers must be included in the cost of power. By the

combination of process and power the number of boilers needed is reduced and the factory owner can feel that, by eliminating part of the fixed charges, he is getting something for nothing.

If high-pressure boilers were installed to permit carrying 335 lb. pressure at 200 deg. superheat, 58 hp. could be developed per 1,000 lb. of steam with a back pressure of 15 lb., and with 45 lb. back pressure 30 hp. could be generated. An examination of the curves should convince engineers and managers that the use of high pressures in process work does not prevent power from being developed with the steam before it enters the main.

The same procedure of first generating power from steam before it is used in the factory applies with equal force to building heating, and of course the use of exhaust steam in heating is almost as old as the engine itself.

What to Do When Power Requirements and Process Steam Demands Fail to Agree

Engineers have made the point that seldom do the power requirements and the process steam demand coincide, and as a result there is a demand for power beyond the amount it is possible to develop from the steam flowing to the processes, or the situation is reversed.

This problem is not as formidable as it may seem and is being solved in hundreds of plants.

Several methods are used. Turbines are provided with extraction connections, so that some steam can be drawn off at a given back pressure, while the remainder flows on through the lower stages of the turbine and passes into the condenser. The amount of extraction or "draw-off" is limited to about 90 per cent of the total steam supplied to the turbine. Other plants have compound reciprocating engines, arranged for steam extraction from the

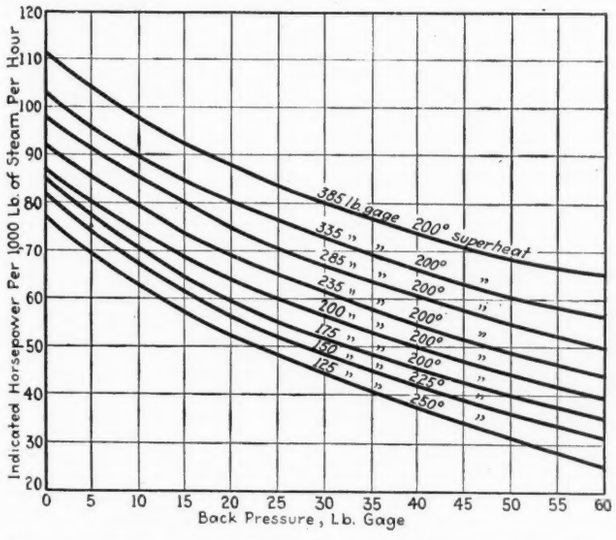

Indicated Horsepower Per 1000 Lb. of Steam Per Hour
Back Pressure, Lb. Gage
385 lb. gage 200° superheat
335 " " 200° " "
285 " " 200° " "
235 " " 200° " "
200 " " 200° " "
175 " " 200° " "
150 " " 200° " "
125 " " 225° " "
250° " "

Fig. 1.—Power developed by a perfect engine, from 1,000 lb. of steam

receiver. A few old-time engines were designed to work one end of the cylinder to exhaust into the condenser, while the other end was to supply steam at a few pounds back pressure. In a recent patent it was proposed to provide a uniflow engine with ports along the cylinder through which steam was extracted to meet process requirements. These arrangements are, obviously, suitable only for installations where the steam needed to develop the power is greater in amount than that required for processing or heating.

When the balance is continually shifting from power to process, live steam must be supplied to the low-pressure main through a reducing valve, unless a steam accumulator be installed to absorb the excess exhaust and return it when the demand exceeds the supply from the engine.

A better plan from a heat-balance basis, but not always from an economic one, is to run two units, one operating

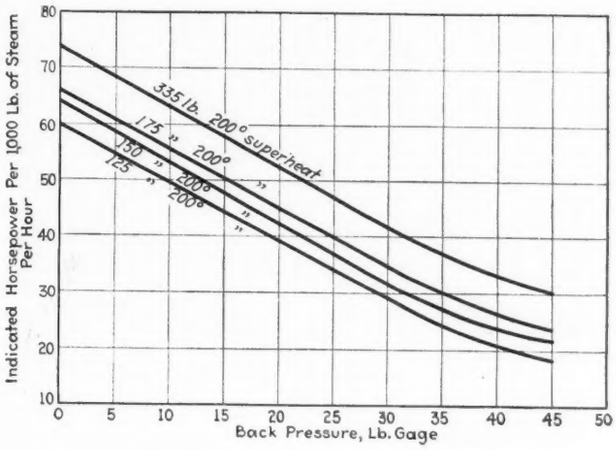


Fig. 2—Output of a uniflow engine at different back pressures

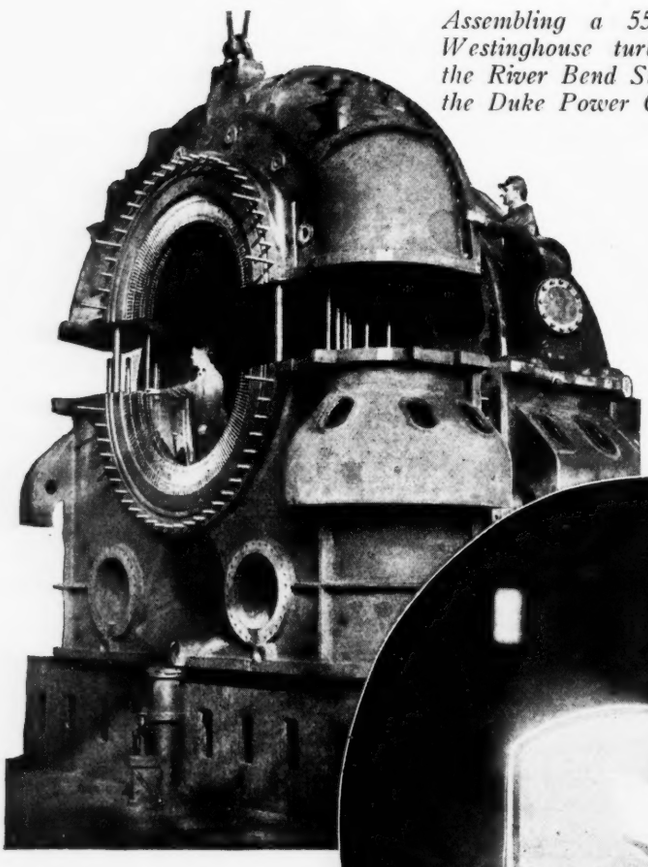
condensing, and the other exhausting into the low-pressure main. This, of course, entails excess engine capacity, for the back-pressure engine must be large enough to carry the greatest possible load when the process demands are highest, and the condensing unit must be large enough to carry most of the load when the process demand is lowest.

The economic advantage of each of these methods will be discussed in a future article.

Conquering Dust!

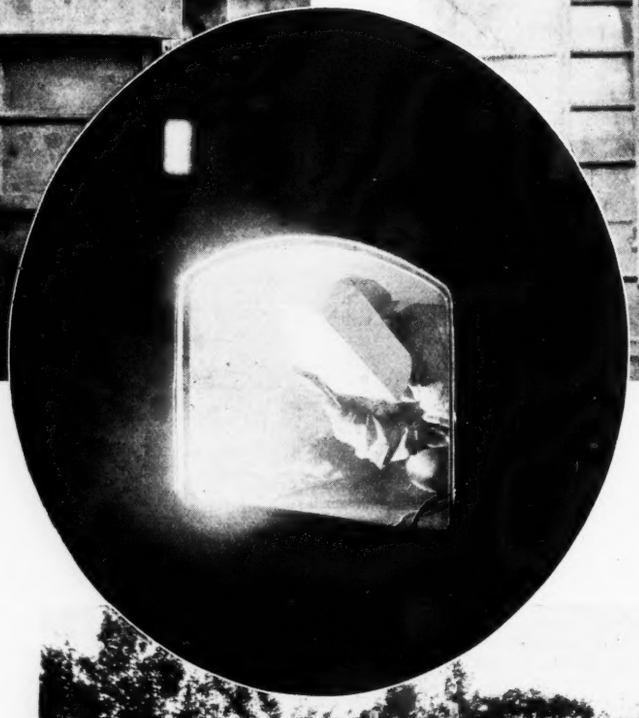
Dust in the stack gas of pulverized-fuel plants has not, because of its extreme fineness, slow precipitation and gray color, caused as much annoyance as was predicted some years ago. Moreover, where necessary this dust can be greatly reduced by electrical or mechanical separating devices. Now the Detroit Edison Company comes forward with a simple and effective method of purifying the dusty vents from "cyclones." At the Trenton Channel Station groups of bag filters, automatically cleaned, remove all but a trace of the dust. The Feb. 19 number of *Power* will give the details of this new development.

"On The Trail of Power"



Assembling a 55,000-kw. Westinghouse turbine for the River Bend Station of the Duke Power Company

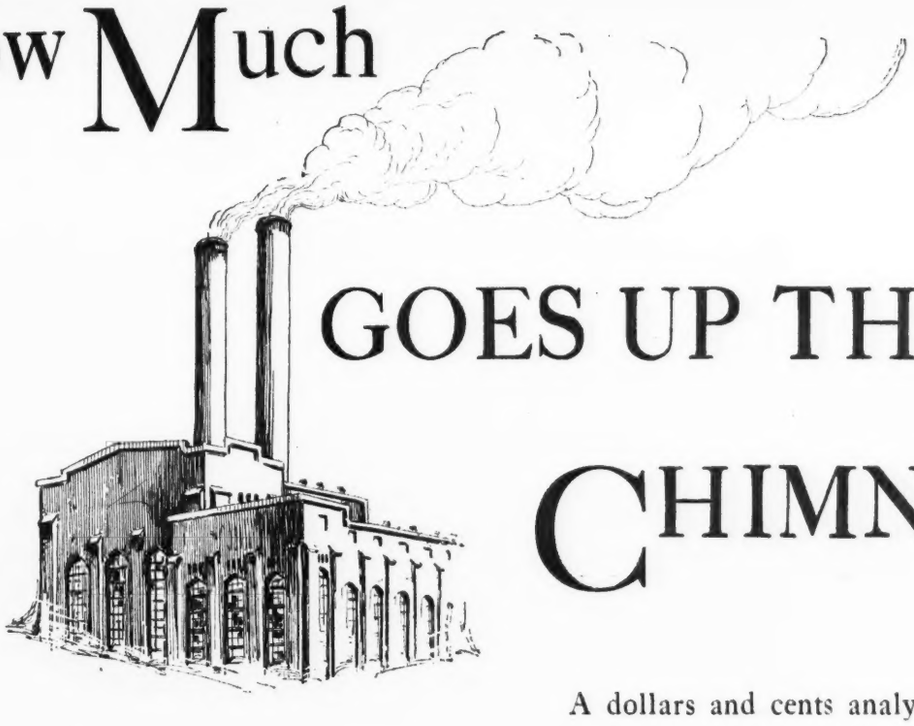
Above — This 26,000-lb. Maxim Silencer hushes the exhaust of a new 3,750-hp. Diesel in the plant of the Tucson Gas, Electric Light & Power Company, Tucson, Ari-



Right—A furnace door? Not exactly, but steel grave vaults, like power equipment, must be tight, so arc welding was called in to do the job

Right — Quaint but not ancient, this 16-ft. overshot wheel in the Franconia Notch of the White Mountains, New Hampshire, drives a direct-current generator which serves a nearby roadhouse. The wooden flume runs back 600 ft.

How Much GOES UP THE CHIMNEY?



By David Moffat Myers
Consulting Engineer, New York

A dollars and cents analysis of boiler losses; a chart for readily determining these losses; and how to reduce them to a minimum

MOST plant owners would like to reduce their coal bills without building new boiler plants. And in most industrial boiler plants this can be accomplished provided the necessary knowledge and management are applied. This is without any regard to what further savings might be accomplished by remodeling or improving the design.

The first step is to make sure that the most economical fuel for the plant equipment and its steam-production needs is being bought. The second step is to inaugurate a suitable system for the continuous control of boiler-house efficiency. This involves, first, a complete understanding and survey of combustion conditions and boiler losses, which will lead in turn to the establishment of right measures of economy. When this has been done, a system must be installed or waste will again creep in and a discouraging slump will occur. Such a system may be very simple, although it must be adapted to the plant needs and to the plant personnel, especially the latter. It must be designed to interest the boiler-house men in their work and at the same time be scientific, common sense and engineering.

Put $100 worth of coal into the boiler furnace and what becomes of it? Where may be found the biggest and most controllable loss? Here are the answers in the form of balance sheets. Two cases are given, one poor, the other much better, and neither extreme.

Boiler and Furnace Conditions	Poor	Better
1. Utilized—Absorbed by boiler to make steam..	$60	$75
2. Loss—Dry chimney loss.....	28	13
3. Loss—Combustible to ashpit.....	4	4
4. Loss—Hydrogen and moisture in coal.....	5	5
5. Loss—CO and unburned gases.....	0	0
6. Loss—Radiation and unaccounted for.....	3	3
Total value of coal.....	$100	$100

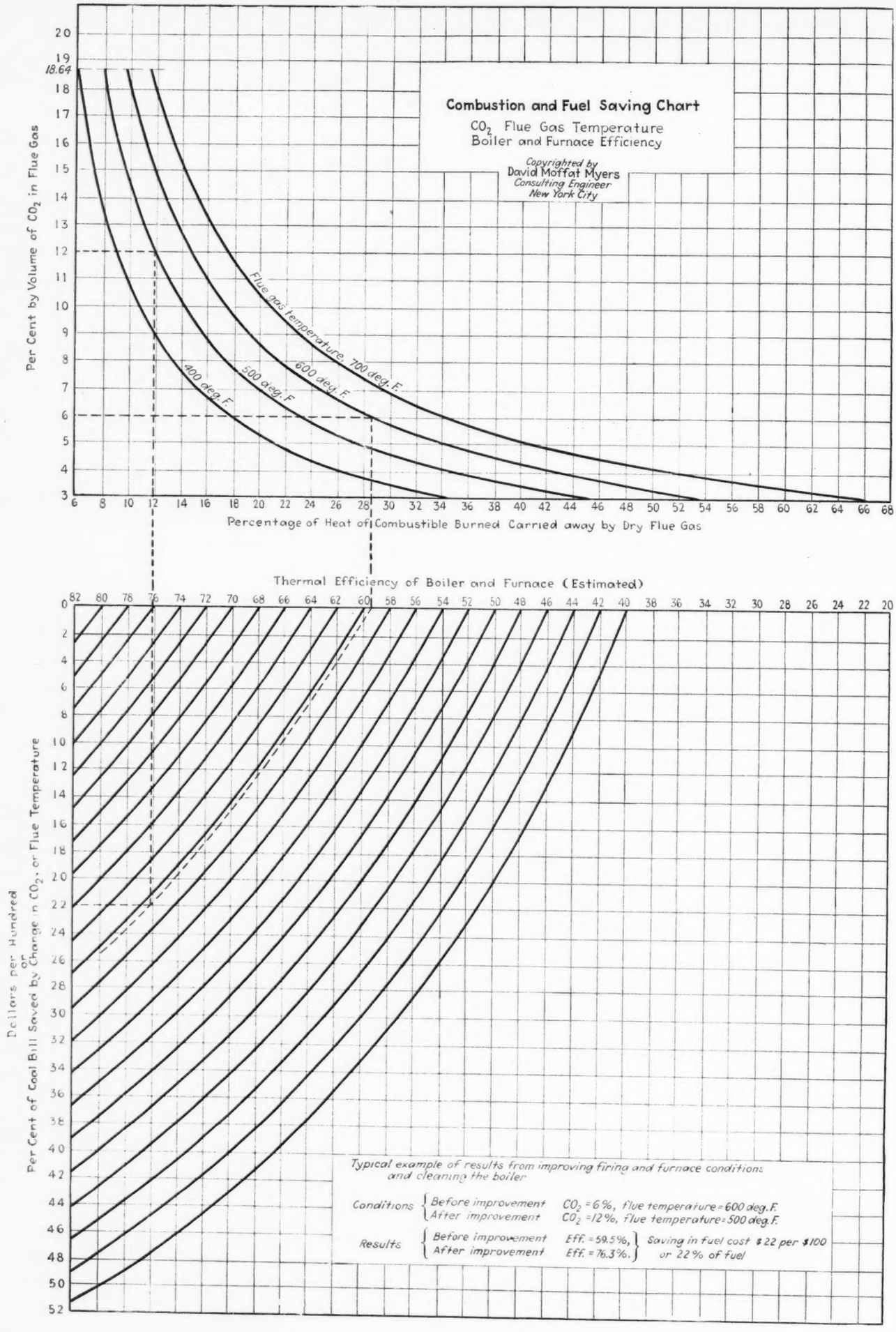
This illustrates typically the answers to both questions asked. What becomes of $100 worth of coal is shown for an ordinary range of efficiency. And the biggest and most controllable loss is item 2, known as the "dry-gas chimney loss."

By comparing the two cases it is clear that, without changing any of the other losses, a saving of $\frac{75-60}{75}$ = 20 per cent in the coal bill has been made to produce the same amount of steam. That is decidedly worth while and is no exaggeration of what can be done and has been done in this way with hundreds of industrial boiler plants. This dry-gas chimney loss, "stack loss" for short, is controlled by definite factors which in themselves are controllable within reasonable limitations.

As to the other losses, *Item 1,* the efficiency of boiler and furnace is that portion of the heat of the coal which has been usefully absorbed by the boiler for steam production. By reducing the various loss items to a minimum, the efficiency will be raised to a maximum. *Item 2* has been briefly touched upon and will be fully considered later.

Item 3. In the best practice this loss can be reduced to a fraction of a dollar per hundred. In poor practice and with poor coal, high in the ash, it may go to five dollars, ten dollars or even more, but it is never to be compared in magnitude with the stack loss under equivalent conditions for both.

Item 4. This covers the heat carried away from the boiler due (1) to the burning of the uncombined hydrogen in the fuel into water (superheated steam), the absorbed heat of the process being lost up the chimney; and (2) to the heat required from the fuel to evaporate its contained moisture and superheat it to the stack temperature. The first of these cannot be controlled once the fuel is selected. This loss may run up to around


Combustion and Fuel Saving Chart
CO_2 Flue Gas Temperature
Boiler and Furnace Efficiency
Copyrighted by
David Moffat Myers
Consulting Engineer
New York City
Per Cent by Volume of CO_2 in Flue Gas
18.64
Flue gas temperature, 700 deg. F.
600 deg. F.
500 deg. F.
400 deg. F.
Percentage of Heat of Combustible Burned Carried away by Dry Flue Gas
Thermal Efficiency of Boiler and Furnace (Estimated)
Dollars per Hundred
or
Per Cent of Coal Bill Saved by Change in CO_2, or Flue Temperature
Typical example of results from improving firing and furnace conditions and cleaning the boiler
Conditions { Before improvement CO_2 = 6%, flue temperature = 600 deg. F.
After improvement CO_2 = 12%, flue temperature = 500 deg. F.
Results { Before improvement Eff. = 59.5%,
After improvement Eff. = 76.3%. } Saving in fuel cost $22 per $100 or 22% of fuel

4 or 5 per cent. The second is subject to slight variation by using drier fuel, but the amount involved except in the case of excessive moisture is extremely small.

Item 5. In the tabulation of losses this item was entered as zero. It can generally be kept close to zero unless furnace and draft conditions are unusually bad, when it may enlarge to undesirable proportions. It is likely to occur with heavy fires and insufficient furnace volume.

Item 6. Radiation may vary from 1 to 5 per cent and is usually between 2 and 3 per cent.

Coming back to Item 2, this is not only the biggest loss, but also the most variable when there is no proper control. But it can be controlled, and the usual loss can be turned into a fat saving.

This dry stack loss is greatest when there is excessive air supply for combustion, due to wrong methods of firing, wrong adjustment of stokers and draft regulation and leaky boiler settings; also, when the inside and outside heating surfaces of the boiler are foul with scale or soot, when the boiler is driven beyond its economical capacity, or when there is a short-circuiting of gases due to leak baffles.

> The instilling in operatives of a desire to do better work is a management problem of the first order. The desire must grow out of interest in the job and there are various ways of inducing interest. One is to furnish the operative with means of knowing what results he is securing; another is a system of rewards based on improved results. In both cases results must be known, and to this end instruments are helpful. If the management is not interested in knowing and getting results, the operatives will not be, and results will be poor.

A definite check can be put on all these troubles in a lump. This check consists of (*a*) an analysis of the gases leaving the boiler and (*b*) the temperature of these gases. The loss is a minimum when the CO_2 is a maximum (without CO) and when the temperature of the escaping gases is a minimum. Every boiler furnace and setting is capable of a certain maximum CO_2 at its best load with a given coal. This maximum is readily found by reducing the draft and adjusting the stoking to run the CO_2 up higher and higher until CO just begins to appear in the gas analysis. One or two tests of this kind are usually sufficient. If the maximum CO_2 happens to be 12 per cent, then 12 per cent is the standard for this boiler. With modern design this maximum may run up to 15, 16 and even 17. Once found, however, the CO test may be discarded unless some definite change is made in the furnace, coal or rating. After this the CO_2 record tells the story of combustion.

Chart Tells Loss in Dollars

The other factor is determining stack loss through the temperature of the gases leaving the heating surfaces. With these two readings the stack loss may be read from the accompanying combustion chart which the author has developed for bituminous coal.

For instance, before improvement of furnace conditions, suppose the CO_2 was 6 per cent (CO = O) and the flue-gas temperature was 600 deg. F.; and after improvement the CO_2 was 12 and the flue temperature was 500 deg. These changes were effected by stopping all air leaks in the setting, improving the firing conditions, adjusting the draft properly and cleaning the boiler. On the chart, by reading along the dotted lines of the example from CO_2 to flue temperature and then vertically downward, the stack loss before improvement is found to have been 28.5 per cent and after, 11.7 per cent. The difference is 16.8 per cent, to be added to the former efficiency of the boiler and furnace.

What this means in dollars can be read directly from the bottom chart. The result is on the conservative side and close enough for practical commercial application.

Continuing vertically down along the arrowed lines into the lower chart, it can be seen that the old[1] efficiency was 59.5 per cent and the new[1] efficiency 76.3 per cent. By following the downward curve beginning at 59.5 to where it crosses the vertical, through 76.3 and reading horizontally to the left, we find that for the same steam production as before, $22 is now being saved from each hundred of the former coal bill.

This combined chart gives a quick and graphic demonstration of what may be accomplished by changing factors that govern combustion and boiler conditions. Its readings of savings are on the conservative side and within commercial accuracy. The estimated efficiencies shown, corresponding to CO_2 and temperature, will usually be somewhat higher than actually obtained, but not necessarily. The savings will actually be secured by changes in the CO_2 and flue temperatures given. These readings are still more conservative for anthracite coal, but do not apply to fuel oil or natural gas.

The efficiency of any process, whether it be the making of motor cars or of steam, is equal to the product of the human factor times the equipment factor. With identical boiler equipment one may often secure a remarkable improvement in fuel efficiency by improving the human factor alone. This involves, first of all, desire on its part to give the best results and, secondly, the necessary knowledge and information.

There are many medium-sized and small plants as well as large ones where it is impractical to obtain an accurate daily record of the coal consumed, so that daily evaporation per pound of coal is out of the question, although steam-flow records may be available. Often, in plants so situated, it is feasible to install a CO_2 and flue-temperature recorder. If this is carried out in combination with a simple system of records, following a determina-

[1] In computing the efficiencies on which the savings of the lower chart are calculated, it was necessary to group the losses other than dry-gas chimney loss and to assign a working value to these, which was placed at 12 per cent. This is a low figure for industrial boiler plants, which means high values for the efficiencies thus deduced. This, on the other hand, makes the computed savings conservative and much more than compensates for the error introduced by using the dry-gas stack loss of the CO_2 chart as based upon total coal instead of combustible actually burned. As a matter of interest the "other losses" in actual tests range from 10 to 22 per cent. The "savings" results of the combined charts are well within commercial accuracy for bituminous fuels and still more conservative for anthracite coals. With the latter a given CO_2 results in a higher dry-gas chimney loss due to the lesser value of available hydrogen content.

tion of the right combustion standard for the plant, remarkable results are possible.

In other plants, differently equipped, this system might not apply so well.

In a plant adapted to the CO_2 and temperature recording method, the combined combustion and fuel-saving chart will serve not only as a measure of savings produced, but also as a gage for the payment of bonuses.

For example, if the use of the savings chart with the records obtained indicates a saving of 10 per cent on a former yearly coal bill of, say, $52,000, this would be $100 a week saved for the company and would be justified in paying an extra $25 or $30 per week to the firemen and engineer for maintaining this standard. Shifts of firemen should never be divided and worked against each other in the paying of rewards. The rewards should be treated as a collective bonus, so that each shift receives the same amount. This insures co-operation, and the different shifts and men will help each other for the common good. The engineer in charge of boiler-house maintenance should receive his share of the reward or credit for improved performance, as he has an important part in the results.

The specific causes of excessive stack losses are all thoroughly known and understood and there is a cure for each one of them, usually simple and inexpensive. Some of these specific causes have already been indicated, such as: (*a*) Too much air admitted through the fire due to uncontrolled draft regulation, firing methods or stoker adjustment. (*b*) Leakage through boiler setting causing low CO_2. A fairly good looking setting has been found to leak as much air as passed through the grates. (*c*) Soot on outside of heating surfaces. (*d*) Scale on inside. The last two items cause high flue temperatures. (*e*) Overloading of boilers causes high flue temperatures. (*f*) Underloading of boilers causes high excess air and low CO_2. (*g*) Unequalized loading of boilers causes low CO_2 in some and high flue temperature in others. (*h*) Short-circuiting of gases causes high flue temperatures.

While the stack loss can be reduced by the use of air preheaters and economizers to bring down the temperature of the escaping gases, and by proper application of stokers or powdered coal for improving the combustion and CO_2, we are here concentrating attention on what may be accomplished with existing equipment by improvement of operating and management methods alone.

Turbine Replacing Reducing Valve Saves its Cost in Less Than Year

By E. C. Rutz

Superintendent Power and Maintenance Division
Bryant Paper Company

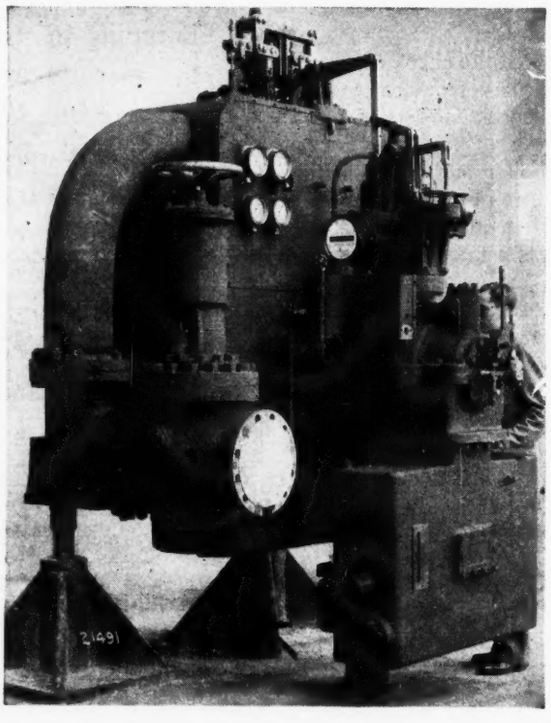
IN SEPTEMBER, 1923, fires were started under the boilers and the new central power plant of the Bryant Paper Company, Kalamazoo, Mich., was placed in service. As indicated in the May 6, 1924, issue of *Power*, this plant, with four 7,780-sq.ft. Stirling boilers, replaced 23 small and obsolete boilers formerly operated in four separate plants.

Electrification of two divisions of the mills was finished in time to be picked up by the new plant. A third division, with equipment operated by twelve reciprocating engines and numerous steam-cylinder operated auxiliaries and pumps, had to be supplied temporarily with steam at 150 lb. until the necessary program of rehabilitation could be worked out. The steam requirement of this division totaled around 60,000 lb. per hour at 150 lb. gage.

As the new plant was designed to operate at 300 lb. gage and a total temperature of 620 deg. F., a reducing valve and desuperheating sprays were provided to handle the 150-lb. steam load. This arrangement was to be temporary, but a change in the plans caused an indefinite postponement of the rehabilitation work.

To recover the power between the two pressures, a 1,250-kva. Westinghouse turbine with a two-row impulse wheel and oil-operated governor was installed to bypass the reducing valve. Nozzle and blading arrangement of the turbine provided for maximum efficiency at a steam flow of 60,325 lb. per hour, but additional nozzles were provided to permit a flow of 100,000 lb. per hour for possible future needs.

Operating as a bypass around the reducing valve, with an initial pressure of 300 lb. gage and a steam temperature of 620 deg. F., the turbine maintains a uniform exhaust pressure of 150 lb. by means of a regulator operating in conjunction with the governor. The electrical output of the machine, therefore, is dependent upon the demand for 150-lb. steam.

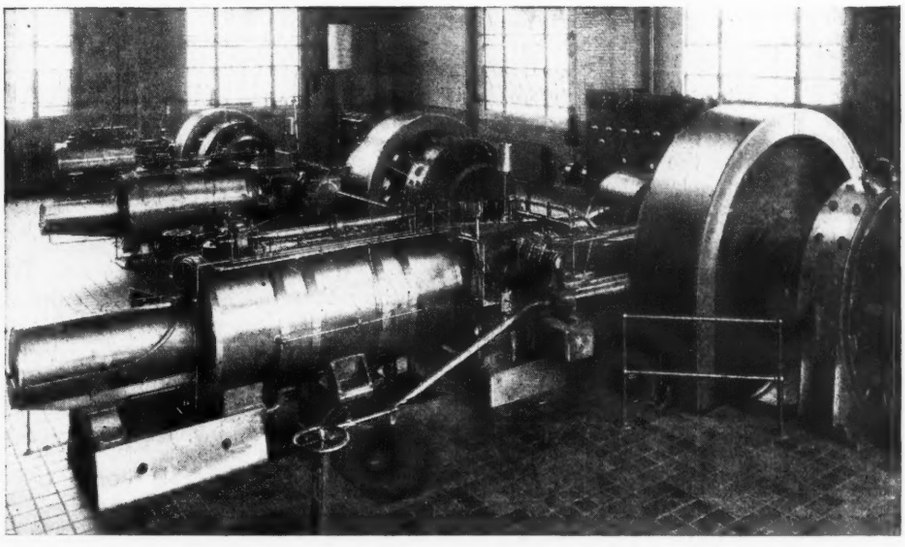


The high back-pressure turbine prior to installation

At present the average output is 18,000 kw.-hr. per 24-hour day, equivalent to a load of approximately 750 kw., the load fluctuating between 650 and 850 kw. over the 24-hour period, based upon the demand for the low-pressure steam.

This turbine was placed in service in April, 1928, and its performance and economies have been so satisfactory that the installation has returned its investment in less than twelve months.

YOU CAN HAVE
Clean Exhaust Steam



By Using Correct Cylinder Oil

The feeling that when steam is needed for process, exhaust from reciprocating engines cannot be used, is based on erroneous thinking. By properly selecting the cylinder oil the exhaust steam can be passed through a separating apparatus and practically all oil removed.

BY ALLEN F. BREWER
Lubrication Engineer, New York

THE use to which exhaust steam or its condensate is to be put will have a direct bearing on the choice of steam cylinder oil. Normally, this oil should be at least partly removed from the steam before it is re-used. As complete a separation as possible is advisable wherever coil heating is to be carried out, otherwise a film of oil may develop on the interior of the coils. Where exhaust steam used for feed-water heating in open-type heaters carries any cylinder oil, this oil will be returned to the boilers and form an insulating film on the tubes.

Here is where a properly designed oil separator or grease extractor is of advantage, especially where a cylinder oil is used that will separate comparatively readily from the exhaust or condensate. The ease with which separation can be accomplished will depend upon the amount of compound used and upon whether the oil has been filtered.

Steam-cylinder lubrication involves the delivering of a sufficient amount of steam-cylinder oil to the valves, valve seats, piston-wearing surfaces and cylinder walls to prevent metallic friction as far as possible and avoid development of abnormal wear. The choice between a straight mineral cylinder oil and a mineral oil compounded with a certain percentage of fixed or animal oil compound is determined by the moisture content and the pressure of the steam.

Where steam is superheated to a point where there is but slight possibility of cylinder or pipe-line condensation, a straight mineral, high-flashpoint cylinder oil should be used for lubrication. The absence of moisture will enable the oil delivered to the cylinder and valves to stick satisfactorily and to form and maintain an effective lubricating film. Furthermore, such an oil will separate more easily from the condensate.

Water, of course, would tend to wash off such a film of straight mineral unemulsified lubricant. As a result, where lubrication must be maintained in the presence of any appreciable moisture, the addition of compound will improve the ability of the oil to stick to the wearing surfaces. The fixed, or compounded, oil aids in the formation of a lather, or emulsified mixture with the moisture in the steam. Such a lather is far more tenaceous than a film of straight mineral oil, and it will resist the washing effects of water, in proportion to the percentage of compound used, the moisture content of the steam, and the extent to which the mineral oil base may have been filtered.

It is important to remember that the use of fixed or fatty oils in steam cylinders may result in the development of free fatty acids. For such oils may undergo a chemical change when subjected to the comparatively high temperatures prevailing.

Such acids are corrosive and, if developed in excess, they may cause serious damage to cylinder and valve wearing surfaces. The corrosion may extend to boiler tubes and heating coils if the nature of the oil is such as to render separation from the exhaust a difficult matter. In consequence, care should always be exercised to use a cylinder oil with as low a compound content as possible. Fortunately, however, a carefully refined, high-grade oil, either mineral or fixed, does not seem to cause this corrosion.

Separation Depends Upon the Compound

Where ultimate separation of the oil from the steam is desired, it is well to note that the nature of the compound used must also be considered. Degras is regarded as capable of developing better emulsification than tallow, for example. This, however, would render the oil carried over by the exhaust more resistant to ultimate separation. Prime lard oil is usually preferred as the compound. Such an oil affords good emulsification in the presence of wet steam and yet does not seem to hinder separation where the cylinder oil is carried over by the exhaust.

Filtered steam-refined cylinder oils have been proved to be capable of more ready separation from exhaust steam or condensate than unfiltered products. They will atomize more readily and can be used where the point of application must be comparatively close to the throttle valve.

On the other hand, the process of filtration will, in general, remove those heavier hydrocarbon constituents which are usually highly adhesive. As a result, where saturated steam is involved, to render a filtered oil capable of adequately protecting cylinder and valve wearing surfaces, careful compounding must be carried out. In other words, compounding is relied upon to increase the adhesive ability which filtration may have decreased. Under average power-plant steam conditions, which will normally involve saturated steam of from 2 to 4 per cent quality, this is quite a necessary characteristic, for the washing action of water must be adequately resisted.

As a result, where separation of oil from the exhaust must be effected, a filtered cylinder stock containing adequate compound to meet the moisture conditions will be most suitable.

Do Not Ignore Viscosity

The question of viscosity is also important. As a general rule the lighter the body or the lower the viscosity of the oil, the more readily will it lend itself to subsequent separation. Normally, however, the viscosity should not show below 100 sec. Saybolt at 210 deg. F., for the service or operating viscosity might be inadequate to maintain protective lubrication effectively. A typical oil for average steam conditions would be a 125 to 135 viscosity filtered cylinder stock, containing about 4 per cent of prime lard oil.

Where steam is superheated and complete separation is of paramount consideration, it may be advisable to consider the usage of an uncompounded straight mineral filtered oil. Under conditions of adequate superheat such an oil should lubricate with complete satisfaction. The fact that such oils will atomize more readily than unfiltered products will be of advantage, for with these latter moisture in the steam is regarded as an aid to atomization. In superheated steam the lack of moisture is not a detriment to atomization if a filtered oil is used.

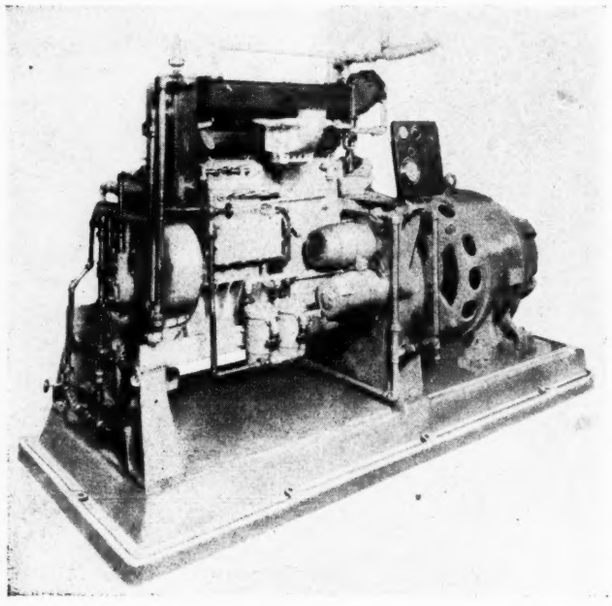
It must be borne in mind, however, that the higher temperatures involved in engines operating on superheated steam may tend to reduce the viscosity of the oil quite materially. As a result, for such service, to maintain an adequate protective film on the wearing surfaces and to insure retention of the adhesive characteristics as much as possible, an oil of comparatively high original viscosity must be chosen. In power-plant service this should range from 160 to 170 sec. Saybolt at 210 deg. F.

By the use of the proper lubricant, exhaust steam can be put through a separator and all oil removed.

High-Speed Diesel Insures Telegraph Service

THE Western Union Telegraph Company must maintain its services at all times. While electricity for battery charging is, as a rule, purchased from the local public utility, it is necessary to have a power plant in the telegraph building to protect against breakdown of the electric lines.

The illustration shows a Buda high-speed Diesel direct connected to a 40-kw. 120-240 volt 800 r.p.m. generator



The Diesel unit installed for breakdown service

recently installed in the San Francisco, Calif., office. A special overspeed safety stop is fitted to the fuel-injection pump. Other protective devices, including a cooling-water regulator, are provided.

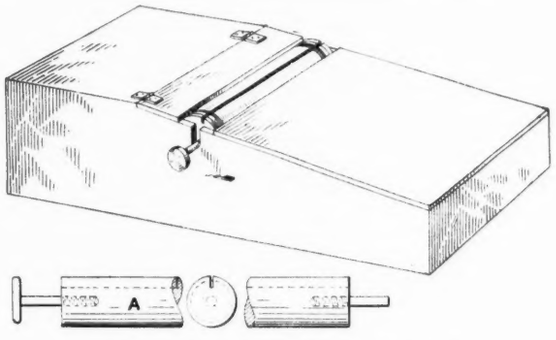
Starting is by an electric starter operated through a magnetic switch on the control panel. In addition, the control panel carries a lubricating-oil pressure gage, a thermometer for the cooling water and a tachometer showing engine speed. The weight of the unit is 10,400 lb. complete.

The specifications called for a total variation in speed, with unchanging load conditions, not to exceed 1.5 per cent of the rated speed. The total variation in speed between no load and full load or between any intermediate load changes was not to exceed 5 per cent of the rated speed. The time required for speed to recover to constant rate after any change in load between no load and full load was to be not over three seconds.

Right Out of the Plant

Handy Desk for Log Sheets

THE illustration shows a handy desk fitted with a roll upon which log sheets can be placed while being made up, doing away with the numerous finger marks they are subjected to in the engine room if laid out flat. This kink is probably an old one to many engineers, but



Desk and detail of log-sheet roll

will probably be helpful to the young engineers in the field.

Roll *A* is made as long, plus $\frac{1}{4}$ in. on each end for margin, as the log sheet is wide. The diameter is the height of the log sheet, minus the margins on top and bottom, divided by 3.1416. It should be made of close-grained medium hard wood. A $\frac{1}{16}$-in. saw slot deep enough to receive the margins of the log sheet should be made the full length of the roll. In placing the log sheet on the roll, the margins are inserted in this slot and the sheet rolled hard against the wooden roll. Elastic bands $\frac{1}{8}$-in. wide over each end and the middle will hold it in place.

Lagscrews with the heads removed serve as the axis or shaft. A wooden hand-wheel on the left serves to turn the roll. The slots in the desk *B* into which the shafts fit should be deep enough to allow the top of the roll to extend $\frac{1}{4}$ in. above the surface of the desk lid.

Keyport, N. J. GEORGE B. LONGSTREET.

Pointers on Making Boiler Manhole Joints

TWO common causes for boiler manholes leaking are the use of too thick a joint ring and badly corroded faces on the cover and boiler. The thinner the ring or gasket used to make a joint of this kind the better. One of the best ways to repair corroded surfaces is to build them up by means of electric welding and finish them by grinding.

Our practice in making a manhole joint is first to clean the surfaces on both the cover and boiler, then smear one side of the joint with white lead and place that side against the cover. The side that goes against the boiler is smeared with black lead or graphite. This insures the joint parting readily from the boiler and remaining cemented to the manhole cover.

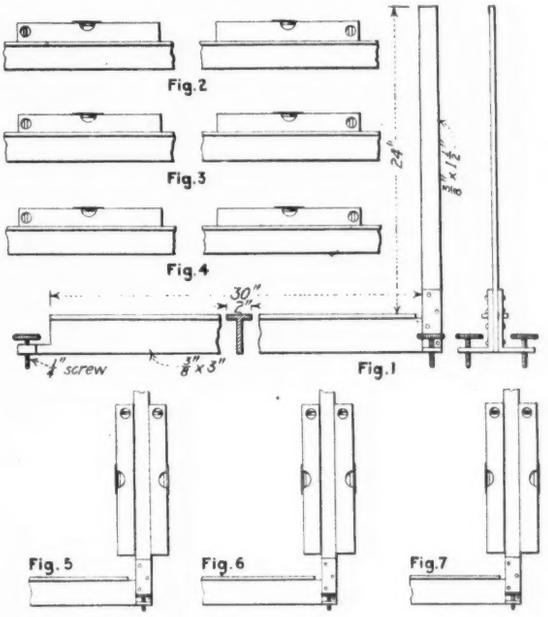
Brentford, England. W. E. WARNER.

Spirit-Level Tester

A USEFUL tool for the power plant, especially during the construction period, is a hand spirit-level tester. It can be placed on any hard and fairly level surface that is free from vibration. It is leveled both ways by using a correct level and adjusting three leveling screws. If a correct level is not available, the level to be tested can be used, the adjustment of the level tester and the level being carried on simultaneously.

Fig. 1 shows the details and dimensions of the tester. The horizontal part is made from a piece of $\frac{1}{2}$x2-in. mild steel to which is welded a piece of $\frac{3}{8}$x3-in. steel to form a T-section. The top surface of the $\frac{1}{2}$x2 in. is accurately machined after the $\frac{3}{8}$x3-in. has been welded to it. This T-section can be cut from a piece of T-iron or can be cut out of an I-beam if desired. The vertical limb of the tester can be made from a piece of $\frac{3}{8}$x1$\frac{1}{2}$-in. mild steel having its edges machined parallel to each other. This vertical piece, which should be at right angles to the bottom piece, can be welded to the horizontal piece or secured with straps and rivets.

When testing the level on the horizontal piece, if the bubble shows as in Fig. 2, which shows the level being tested in first and reversed positions, then it is the level glass that needs adjusting. If as in Fig. 3, it is the



Details and dimensions of the level tester

level tester that needs adjusting. If as in Fig. 4, then both the level and the level tester need adjusting.

When the plumbing glass is being tested, the level is applied to each edge alternately, and if the bubble appears as in Fig. 5, then it is the glass that is not correct. If as in Fig. 6, the testing arm is out of vertical. If as in Fig. 7, both the glass and the arm need adjusting. E. J. JORDAN.

Long Beach, Calif.

Armchair Engineers

RECENTLY, when reviewing my file of "editorials" and engineering articles clipped from *Power*, I reread the article by G. H. Kimball, on "Improving Operation of Small Plants," which appeared in the Jan. 15 issue. In my opinion this article is thorough and should give food for thought to the "engineer" who feels secure because he has a good easy job and doesn't have to interest himself to improve plant operation and effect economies.

These so-called "armchair engineers" are largely responsible for the shutting down of so many plants and the purchase of power from public utility companies. The article in question should also apply to large plants, because they, too, are lacking in knowledge or efficiency and co-operation from the management.

I have in mind two large plants of which I was chief engineer. Both were in a deplorable condition and disorganized when I took charge. In one the saving effected in the fuel alone was 21 per cent in less than a year's operation, not taking into consideration several other items. Prior to my appointment the plant was on the verge of being shut down, but under my administration it was put back into operating conditions and we were able to carry out our proposed program of improvements. However, in the shuffle later on, I lost my position.

In the other plant conditions were deplorable. Practically every piece of machinery was in need of immediate repairs and replacements. Had I known the exact conditions, I would not have accepted the responsibility, because the chance of ruining my character and reputation was greater than that of making a reputation under these trying conditions.

To illustrate briefly one of the many conditions that existed, I had one of the boilers opened up for inspection and found the tubes badly scaled, bottom blow-pipe perforated at the threads, butt straps opened owing to being calked with a chisel, headers opened and heavily scaled, furnace linings, arches and baffles in need of repairs, the angle rails of the stokers worn and practically the entire stoker equipment in need of repairs. I managed to stay in this plant for six months after one of the most trying experiences of my career. I finally did get the plant in fairly good condition after working seven days a week, fourteen hours a day and sometimes eighteen to twenty hours. The men were poorly paid, consequently I had no engineers of real merit, so the lot naturally had to be mine. In this plant we had eight boilers, so it could not be termed a small one.

In conclusion I wish to say that just as soon as I began to make an impression and show improvements in plant operation, I found myself facing opposition from the management through my immediate superior, because I wore a white collar and tie instead of a pair of overalls. When this condition was apparent, I secured another position and resigned. Since I left, this plant has had three chief engineers and conditions are about the same.

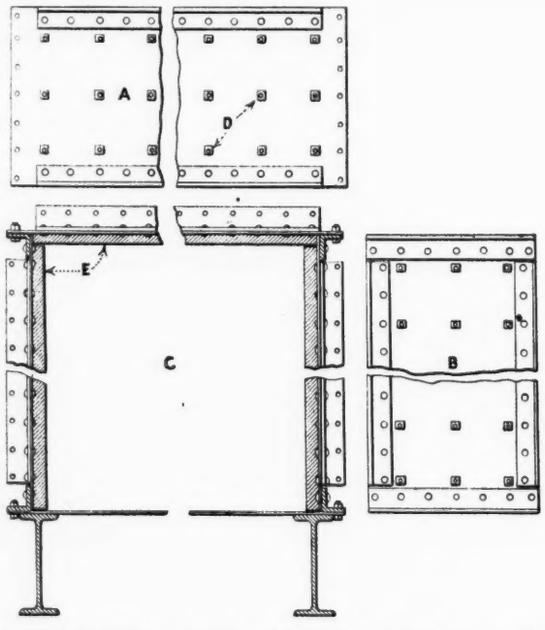
Mr. Kimball's article does not deal with the real engineer of merit, but suggests to the so-called "armchair engineer" that he should get off the chair and get busy or otherwise he may lose his position. My article gives the other side of the picture—what a real engineer of merit, character and reputation has to contend with.

Referring to the "armchair engineer," he is generally asleep at the switch and has no one to blame but himself. My present position as chief engineer of a modern pulverized-fuel plant is the result of such a case. This position called for a competitive examination, and I received the appointment on merit as the result of being prepared and meeting the requirements and qualifications for this particular position.

P. DIAS, Plant Engineer,
Newark, N. J. Essex County Hall of Records.

Repairing a Breeching While in Use

SOME time ago it became necessary to repair the breeching between the boiler-house wall and the smokestack of our plant. The length of this flue was 22 ft. It was made up of $\frac{1}{4}$- and $\frac{3}{16}$-in. plates riveted together and was high above a railroad track. We decided to rebuild the flue with smaller plates bolted together, in order to simplify the work of putting them in place. The bottom plates were good and were not replaced. The new side plates had angle irons riveted to them along their edges, but the top plates had angles along the sides only, as shown in the illustration. The other legs of the angles were drilled so that when the



Breeching built up of insulated sheets bolted together

plates were butted together they could be bolted easily from the outside.

To protect the inside surface of the breeching from corrosion, each plate had bolted to it, with brass bolts, sheets of vitrobestos one inch thick. Cement was used to seal the joints.

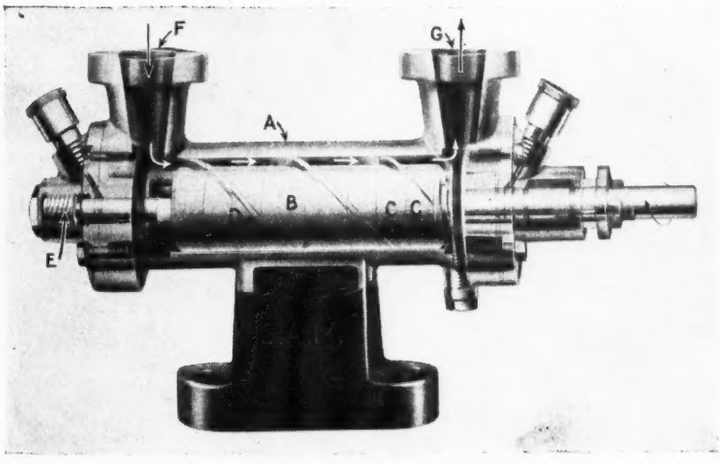
As our plant runs continuously, the breeching had to be repaired while in use. This was accomplished by removing an old plate and at the same time sliding a new one into its place. In the illustration, *A* represents a plan of the top plate, *B* a plan of the side plates. *C* is a section of the breeching after repairs and *E* is the vitrobestos lining.

The corrosion of the side and top plates was undoubtedly due to the sulphur in the coal, while the bottom plates were apparently protected by the ash and soot which collected on them and which were kept dry by the heat.

W. L. PARKER.
Elgin, Ill.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Phantom view of S.A.M. screw pump

Self-Priming, Valveless Screw Pump

SIMPLICITY, light weight and small size for a given capacity, and the ability to handle liquids without churning or emulsifying, are important features of the screw-type pump illustrated. The pump, which was developed in France, is known as the S.A.M. and is manufactured and distributed in this country by the S.A.M. Pump Corporation, 11 West 42nd St., New York.

The pump consists essentially of a cast body *A* with plain cylindrical bore and an eccentrically mounted rotor *B* which is smaller in diameter than the bore and is mounted eccentrically with minimum clearance at the bottom. The rotor *B* is made up of a number of disks *C* mounted on a shaft. Two diametrically opposite slots are cut in each disk and a blade *D* fits loosely in each slot. With all the blades in position the equivalent of a double screw thread is formed on the rotor, the blades being kept in contact with the cylinder bore by centrifugal force.

The closed end of the shaft is hardened and made to bear against the hardened steel button inserted in screw *E*, this simple bearing being adequate to take care of the end thrust in the rotor shaft.

In operation, liquid entering the pump through the inlet *F* is caught between the two threads formed by the blades and, since it cannot follow the motion of the blades around the shaft, is caused to flow through the length of the cylinder to the discharge *G* in essentially straight stream lines parallel to the axis. Any wear on the blades is taken up automatically without affecting the efficiency of the pump or the rate of discharge. Other important features of the pump are: Self-priming (will draw 29 in. vacuum on closed suction); unusually high suction lift; operates at standard motor speeds so that it can be direct connected; no pulsation in discharge; and light weight for a given capacity.

Cleaning and Lubricating Liquid for Commutators and Slip Rings

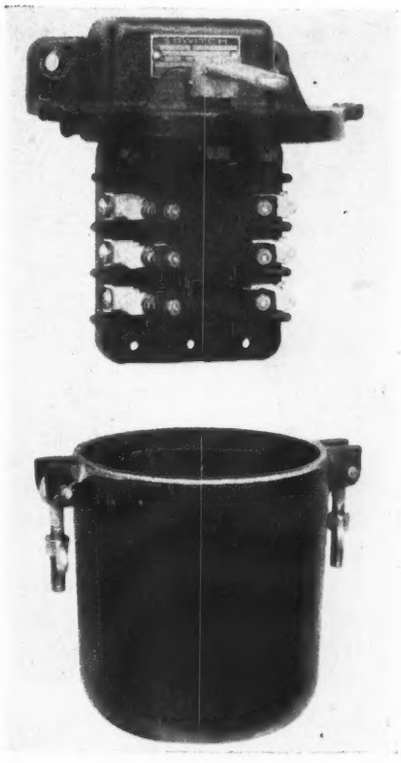
A CLEANSING and lubricating liquid, known as Cramolin, for use on commutators, slip rings and similar rubbing surfaces which conduct electric current, is being introduced in this country by Cramolin, Inc., 25 West 43rd St., New York City.

The liquid, which has been used quite extensively in Europe, is claimed to loosen automatically and remove dirt or foreign substance causing resistance between commutators or slip rings and the brushes. It can also be used to supply a thin lubricating film on rubbing parts that are difficult of access, as it is claimed to be non-resinous and non-crusting.

Across-the-Line Switch Is Oil-Immersed

A NEW General Electric control device is a small oil-immersed switch for use in throwing small alternating- or direct-current motors across the line. It is of simple construction, having a small number of parts—a one-piece cast-iron cover, including the switch mechanism, and a small, cast-iron tank for the oil, as shown in the figure.

The molded compound switch base



Switch and its oil tank

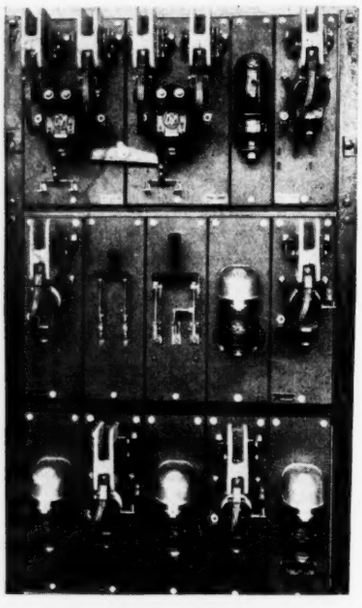
carries the stationary contact stud parts, and the moving contact assembly is mounted on another one-piece molded part. The contacts are of the silver-to-silver, double-break type, which, with the molded arm, eliminate shunts or drum-type contacts.

The cover is provided with two mounting holes, making the switch suitable for wall mounting. Provision is made for conduit connection by means of an incoming conduit box cast into the cover. The molded switch base is bolted to the cover. The cover has a groove, lined with felt, into which the top of the tank fits, thus providing a tight installation.

Time-Current Control System

A NEW system of control which is neither time limit nor current limit, but time-current control, using an acceleration relay, is put out by the Electric Controller & Manufacturing Company of Cleveland, Ohio.

It is claimed that this time-current acceleration relay has the advantages of the usual systems of acceleration, and that on light loads, such as screwdowns, mill tables and other drives where fast operation is necessary, the time-current control gives maximum output. On heavy loads accelerations up to two seconds per step can be had



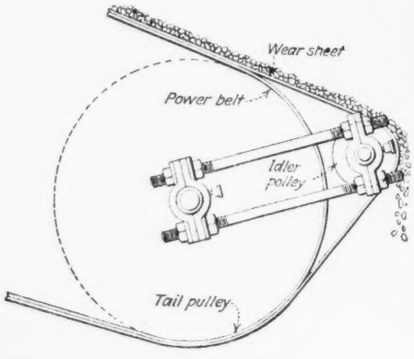
Control board equipped with time-current control relay

automatically without any change in adjustment. On normal loads the forced acceleration increases the torque gradually until the motor starts. A complete line of shunt contactors and a plugging relay, as well as the time-current acceleration relay, are embodied in the control illustrated.

Duplex Conveyor System

A NEW system in belt conveying, known as the Duplex, has been introduced by the Boston Woven Hose & Rubber Company, Cambridge, Mass. In brief, it consists in the superposition of a wear sheet, or pad, upon the conveyor belt, whereupon the latter serves merely to transmit power, while the wear sheet carries the load and takes the abrasion. The wear sheet is made in various thicknesses up to one inch, depending upon service. It is manufactured from pure gum stock with two plies of duck, one at the face next to the power transmission belt and the other at the center. This construction permits extreme flexibility of the belt and at the same time prevents stretch.

In some kinds of conveying it is desirable to reduce breakage, and the



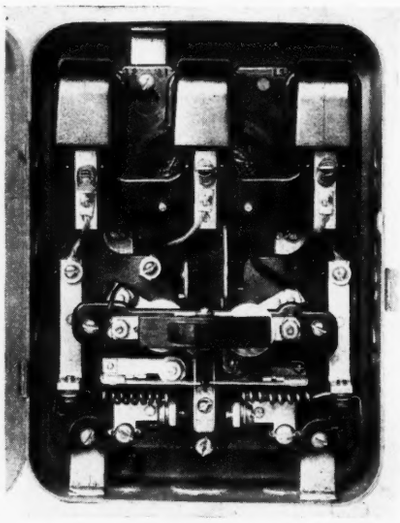
Wear sheet over standard belt takes the abrasion and wear

use of the wear sheet permits this, as it is possible to run the sheet over an idler pulley at the tail, much smaller than the standard tail pulley, as shown in the illustration, thus making possible a short drop of the discharged material. Wear sheets are obtainable for operating on materials at temperatures up to 500 deg. F. For such service the sheet is manufactured with wire-inserted asbestos cloth and makes use of a compound especially adapted to withstand high temperatures.

Among the advantages claimed for the Duplex system are savings in conveying costs, ease of replacement, less breakage of material, possibility of troughing at any angle up to 45 deg. without injury to the wear sheet, use of a narrower power belt than would be necessary to carry the load, increased life of the power transmission belt, and a saving in conveyor cost through the possible use of smaller sizes of head and tail pulleys for the power belt.

Across-the-Line Magnetic Starting Switch

AN AUTOMATIC magnetic starting switch for single-phase and polyphase motors has been placed on the market by the Diamond Electrical Manufacturing Company, Los Angeles, Calif. This switch, shown in the



Type of switch used for polyphase motors

figure, is for connecting the motors directly to the line and is arranged for either two- or three-wire control. It can be used as a complete control for squirrel-cage motors and is also suitable for the primary control of slip-ring induction motors, when used with a faceplate or drum-type secondary resistor control. When used for the latter service, the secondary control should be provided with primary contacts to interlock with the magnetic line switch.

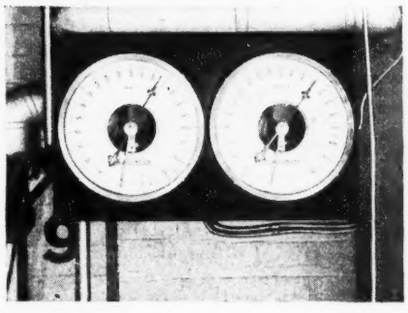
Overload protection is provided by thermal relays with interchangeable elements. Low-voltage protection can be had on some forms of these switches when they are operated either by a lever-type control switch or by a three-wire momentary-contact push button. Low-voltage release is had on other forms, controlled by a two-wire pilot device such as a snap switch, pressure switch, float switch or other two-wire control.

These switches are supplied in full-drawn boxes having ample wiring space and knockouts, in all directions, for conduit connections. The panel is easily removed from its box by loosening three supporting screws. Ratings are available up to 7½ hp. or 25 to 30 and 50 to 60 cycles and 110 to 440 volts.

Remote-Reading Liquid Level Gage

THE distant-reading tank gage illustrated, made in a number of different models, has been recently introduced by the Liquidometer Corporation, Skillman Ave. and Hulst St., Long Island City, N. Y. This gage employs a float consisting of a cylinder, long in proportion to its diameter, pivoted at its center point. This is mounted on the end of an arm which is pivoted at a fixed point midway between the possible upper and lower levels of the liquid. A linkage, connecting with the arm, greatly reduces the motion of the float and communicates it to a balanced hydraulic transmission. The latter is one of the principal features of the device and permits the dial indicators to be located a considerable distance from the tank.

The transmission consists of two pairs of metal bellows, each pair connected by small copper lines filled with a non-compressible liquid. One pair of bellows is located at the tank and the other within the indicating or recording instrument. Any motion of the float expands one bellows while it compresses the other at the transmitting end by an equal amount, so that the corresponding pair of bellows in the indicator reflects the change. Any change in the volume of the transmission fluid due to temperature variation is compensated in the indicator mechanism. The latter converts the differential motion of the two indicating bellows into rotary motion of the indicating pointer, which moves on the face of the instrument. Through the use of the dual transmission systems motion of the pointer is positive in both directions and an increase of pressure in one system is balanced by a decrease of pressure in the other.



Dial indicators of industrial-type Liquidometers

Industrial Liquidometers are provided in a number of sizes ranging from a 24-in. dial indicator to an industrial type with a total pointer travel of 10 in. All are adapted for use on tanks which may be either under pressure or under vacuum. Special facilities are available for producing dials calibrated for any tank size or shape.

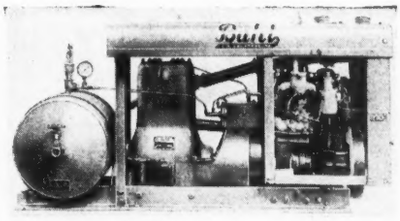


Fig. 1—Compressor and receiver mounted on structural frame

Interchangeable Parts Feature New Line of Compressors

A NEW line of air compressors offering the user an unusually wide selection in sizes and styles is produced by the Buhl Company, Old Colony Building, Chicago. The line is available in 30, 55, 90, 100, 110, 220 and 330 cu.ft. displacements. Various styles of mountings are available. One of the most unusual and important features is that all parts except the crankshaft unit are interchangeable on all sizes and types of compressors.

Lubrication is obtained by a pump force-feed system. All bearings are bronze-backed and babbitt-lined. A bell-housing connection between the engine and compressor is claimed to give all the advantages of a single unit. The illustrations show the 30- and the 220-cu.ft. units. The 330-cu.ft. unit has a three-cylinder compressor. An instrument board groups all instruments in an easily accessible position.

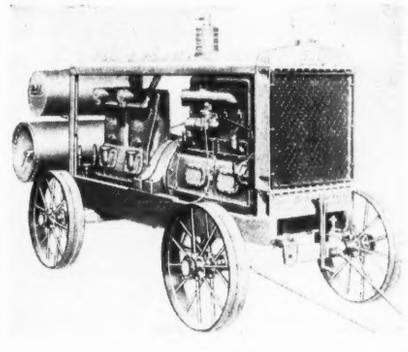
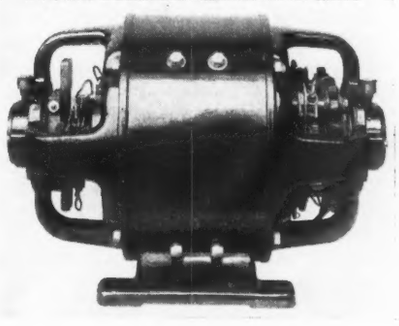


Fig. 2—Portable unit complete with receiver

Converter for Operating Electric Signs

NEON-GAS electric signs operate only on alternating current and require a suitable transformer where the power supply is alternating current. When direct current only is available, it is necessary to use a machine to convert the direct current into alternating. For this purpose, Roth Brothers & Company, 1400 W. Adams, St., Chicago, Ill., have developed an inverted rotary converter, shown in the figure. These machines have a special type of winding designed for the severe operating conditions found in this class of work.

Special speed regulation, which affects the frequency of the machine, has been worked out so that sign failure due to improper frequency is practically impossible. The power factor of the load must be kept in mind when designing machines to supply alternating current. These converters are designed to operate satisfactorily on gaseous-sign loads where a power factor of 30 to 40 per cent is the general condition.



Converter will operate on low power-factor loads

Either two-wire single-phase and four-wire two-phase machines may be had. The two-wire machines are designed to convert 115- or 230-volt direct current into single-phase 110-volt 60-cycle alternating current. The four-wire machines convert 230-volt direct current into 110-volt 60-cycle two-phase alternating current. Continuous ratings for the single-phase machines range from 0.3 to 2.5 kva. and for the two-phase designs from 2.5 to 12.6 kilovolt-amperes.

Ball bearings are standard on all machines, but if very quiet operation is necessary, sleeve-bearing-type machines are recommended. Screen inclosing covers that have been approved by certain electrical inspection departments can be supplied when required.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

FIRST DIESEL IN AMERICA—*Who designed the first Diesel engine sold in this country?* P.P.

The first American Diesel was designed by A. J. Frith and was installed in Cleveland, Ohio, in 1900.

This was a single-cylinder unit 11-in. bore by 20-in. stroke and was rated at 20 hp. The two air compressors were included in the working cylinder casting.

WATER VAPOR IN COLD AIR.—*Is it possible to pass air through a dehumidifier and totally remove the water vapor by spraying brine that has a temperature below 32 deg. F.?* P.R.L.

You cannot remove all the water vapor. It is quite true that the steam tables start at 32 deg. F., but this is for the reason that below this temperature H_2O does not exist ordinarily as water and only as ice. But around the ice there is a small amount of water vapor. By spraying, the vapor will be removed from the air until there is left only that amount corresponding to that existing over ice at the brine temperature.

REDUCED AIR SUPPLY CAUSES CLINKERS.—*An engineer has made the statement that in cold weather closing the boiler-room doors reduced the air pressure in the room and caused clinkering in the furnace. What is the explanation?* C.F.E.

The conditions are possible. It is usual to operate a furnace so that there is at least 25 per cent excess air. This prevents the furnace temperature going so high as to cause the ash to fuse and clinker. If the boiler-room door is closed, the pressure in the boiler ashpit will be reduced, by reason of the decreased air flow into the building. This decrease in draft reduces the air supply up through the fuel, and if the supply is sufficient to complete combustion, the furnace temperature will be increased and clinkering may result.

SATURATED AND SUPERHEATED STEAM.—*What, if any, is the difference between saturated and superheated steam?* M.B.S.

Steam that is at the evaporation temperature corresponding to its pressure is said to be "saturated steam." When steam formed in a boiler rises from the surface of the water, it is saturated, and will remain so as long as it is in contact with the water, and so long as the steam is in a boiler in close communication with the water it cannot be other than saturated, for any attempt to heat the steam to a higher temperature will fail, as the heat will be transmitted to the water and cause further evaporation. Saturated steam may be perfectly dry, or it may be "wet" saturated steam containing suspended particles of water, just as water is suspended in the atmosphere during a fog. Whenever steam is mentioned without qualification, it is understood to be dry saturated steam. Superheated steam is steam whose temperature is higher than the evaporation temperature corresponding with its pressure, and to effect superheating of saturated steam it must be heated away from water to a higher temperature than the temperature of saturated steam of the same pressure and without changing the pressure.

HEAT LOST BY UNJACKETED STEAM KETTLE.—*In our candy factory we have a steam kettle that has 180 sq.ft. of outside surface. With steam at 150 lb. gage and a room temperature 70 deg. F. what is the heat loss through the uninsulated kettle to the room?* G.R.C.

The steam temperature at 150 lb. gage is 366 deg., making the temperature difference 296 deg. While a bare steam pipe will have a heat loss of 3.26 B.t.u. per sq.ft. per hour per degree of temperature difference under the given condition, in the kettle the rate will be lower, as there will be no steam flow washing the condensation from the kettle inner wall. It is safe to assume a coefficient of 2, making the total loss per square foot $2 \times 296 = 592$ B.t.u. For the 180 sq.ft. the loss would be 106.560 B.t.u. per hour. The loss would be reduced by approximately 75 per cent if a one-inch coating of 85 per cent magnesia, or equivalent insulation be applied.

GENERATOR WILL NOT MAINTAIN NORMAL VOLTAGE.—*I have a direct-current generator directly connected to a steam engine running at 120 r.p.m. When the generator is cold it will develop its rated amperage (478) and voltage (110). As soon as the field coil becomes warm the voltage gradually drops until it reaches 80, at which time I start a high-speed engine-driven generator and let it float on the line.*

The engine speed has been increased to 135 r.p.m., but this does not cure the trouble. The large generator was purchased second-hand, and after it was started it would not generate until the fields had been excited. The machine works satisfactorily now, except that it will not hold its voltage. I have tested the machine for grounds and short circuits, fitted the brushes and checked the neutral point on the commutator. The generator is compound wound without interpoles. I would appreciate suggestions as to what might be the cause of the low voltage. H.G.B.

Although some of the information given might indicate otherwise, the low voltage is probably due to the series-field windings being connected to oppose the shunt-field winding. This can be checked by crossing the series-field coil leads if they are long enough to allow this to be done. If the series field coil leads cannot be crossed, shift the brushes one pole space on the commutator and cross the shunt-field leads. If the two fields are opposing with the original connections, when the series-field coil leads are crossed, the voltage should be materially increased over that obtained with the original connections.

If it is found that the original connections of the machine are correct, then the polarity of the polepiece should be checked to see if it is correct. The polarity of the series-field coils should also be checked. If some of these coils have the wrong polarity they might have a bad effect on the machine's operation, irrespective of the relation in which they are connected to the shunt coils. Another suggestion is to test the shunt-field coils for short circuits in the coils.

HIGHER SPEEDS GIVE LOWER BEARING PRESSURES.—*We have a four-stroke-cycle Diesel, size 20x27 in. The crankpin bearings pound out and it has been suggested that by speeding up the engine the bearing pressures will be reduced. How is this possible?* A.C.L.

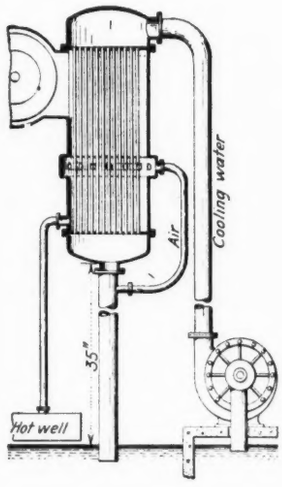
It is, of course, impossible, without complete data, to say that increased r.p.m. will reduce the bearing on a particular engine. Nevertheless, on slow-speed engines this seeming paradox can be made to occur.

The explanation is that the maximum gas pressure exists during the early part of the power stroke, totaling, say 150,000 lb. During the early part of each stroke the reciprocating parts must be accelerated, which force reduces the net force transmitted to the bearing by the gas pressure. If this inertia force at 164 r.p.m. is, say, 50,000 lb., the maximum net pressure in the bearing is 150,000—50,000 = 100,000 lb. If the speed is increased to a point where the inertia force is 75,000 lb., the net on the crank bearing is then 150,000—75,000 = 75,000 lb. At the beginning of the suction stroke the only force is the inertia of 75,000 lb., so it will be seen that the maximum bearing pressure has been reduced by increasing the speed.

PROBLEMS

ANSWERS

from Our Readers



THE QUESTION

IS THE barometric-type surface condenser feasible? If not, why? It is proposed to place the condenser and turbine at such an elevation that the pressure in the tubes is slightly less than the condenser shell vacuum. This would prevent a leakage. Condenser, and the barometric pipe would be as shown in the illustration.

G. W. C.

THE best answer to the feasibility of the barometric-type surface condenser is the fact that such condensers are successfully used in the municipal electric light plant at Nashville, Tenn.

However, several changes must be made in the installation plan shown in the question. The height of the tail pipe should be from 35 to 40 ft. The air connections to the tail pipe should terminate in a long-radius ell pointing downward in the tail pipe, to better the vacuum by utilizing the jet effect of the circulating water.

The pump suction should go down to the bottom of the circulating water so that the pump may not lose its prime because of a lowered water level. The circulating water pump must be capable of raising the water to the height of the condenser inlet when starting up, but when the vacuum is once established, the head on the pump is simply the difference between 34 ft. and the height of the cooling-water inlet above the well-water level.

With these changes made, a very good vacuum can be obtained without the use of air pumps, the degree of vacuum depending, of course, upon the temperature of the cooling water and the amount pumped.

RAYMOND F. FORBES.

Indianapolis, Ind.

FROM the drawing it appears that the designer intends to draw a vacuum in the condenser shell as well as in the tubes by allowing the waste cooling water to drop 35 ft. This method will undoubtedly draw a partial vacuum, but its main objection is that it can take from the condenser only a volume equal to that of the water which flows down the barometric pipe. As that same volume of cooling water is continually being fed into the condenser tubes, it is evident that this method could never hope to remove any volume whatsoever of gas or air from the shell.

D. C. HARDEN.

Oklahoma City, Okla.

THE main requirement of the usual condenser installation is to reduce the back pressure on the prime mover. The barometric surface condenser satisfies this demand and, in addition, permits the recovery of the condensate, a feature that may be of importance in some installations. It is especially adapted to replace an existing barometric jet condenser installation with the object in view of saving the condensate for re-use.

Whether an installation similar to that in the sketch would be practical or not would depend upon the local conditions and upon the results desired. For high condenser efficiency it is necessary to present dry heat-transfer surfaces and to remove the condensate at the maximum practical temperature. In the condenser, as illustrated, the condensate running down the tubes in a film, would reduce the dry-tube surface. Theory demands that the condensate travel from the place of condensation to the discharge outlet without coming in contact with other condensing surfaces.

Should a high vacuum be desired in this installation, a steam-jet air pump installed in the air-removal line would be efficient, as it would operate against a partial vacuum instead of atmospheric pressure.

It would seem that the barometric surface condenser would be feasible only where a conventional type was not practical.

E. M. GAY.

Norwich, Conn.

THERE are several factors in this installation which condemn it. The tailpipe, which is 35 ft. long, indicates that a vacuum of no less than 15.15 lb. or 30.86 in. Hg. has been considered. This vacuum is greater than that which can be counterbalanced at sea level. Aside from minor tube leakage from the steam space to the condenser head, there is the matter of vaporization of the circulating water itself. This would occur under any temperature of circulating water that could be used, for the temperature at the discharge end would be at least ten deg. higher than the inlet temperature, and this would merely aggravate the condition. In short, the column of water, unless flowing with such a velocity as to offset the creation of a zone of low pressure at the condenser head, would break, the air would not be withdrawn from the steam space and the load on the pump would be increased.

Another item is that of the pump impeller itself. For efficient operation an impeller is designed for service against a nearly constant head. Inasmuch as no steam jet could evacuate to a higher vacuum than that against which it operates, the pump would have to be so designed as to be able to fill the circuit. This would entail a loss in the over-all performance due to a low pump efficiency.

S. G. HOPE.

A Question For Our Readers

WILL there be a loss in its heating value if coal is stored under water? What is the cause of the difference?

P. G. S.

Suitable answers from readers will be paid for and published in the April 9 issue

Properties of Steels

can be used to

Predict Worth in Service

IN THE application of a steel to a specific purpose, the work done in the static tensile test is in itself a minor consideration, as the steel must meet certain requirements of two distinct kinds, strength and ductility. It must have certain strength (ultimate tensile); it must have a certain ability to resist deformation (yield point); it must have a certain ability to deform uniformly (elongation) and locally (reduction of area) without fracturing. Moreover, no matter how good any one, two or three of these properties may be if the fourth is low the steel may still be unsatisfactory for a definite application unless the factor of safety is high.

Each of the properties in question is a factor, although not necessarily a factor of equal importance. Each factor must be appropriately weighted. The most convenient method of weighting a factor is to give it an exponent whose value may be varied for any particular case. In this way worth may be expressed as

$$W = Y^m, U^n, El^c, R^d$$

where Y = the yield point; U = ultimate strength; El = percentage elongation in 2 or 8 in.; R = function of the reduction of area previously defined; m, n, c and d = exponents determining the relative weight of each of the factors, depending on the specific application.

The previous equation gives a value for absolute worth, which in itself has no meaning. However, relative worth has a very real meaning, and is the real crux of the matter. Reasoning thus, relative worth may be expressed as

$$\frac{w}{W} = \left(\frac{y}{Y}\right)_m \left(\frac{u}{U}\right)^n \left(\frac{e}{El}\right)^c \left(\frac{r}{R}\right)^d$$

In this formula the small letters represent the values for the material under consideration and the capitals the values with which they are being compared.

It is evident that if some "absolute worth" value is assigned for a basis of comparison, all other values become absolute as well as relative. This may be readily done by assigning as standards the properties which are known to be mean properties for satisfactory service. Physical tests are used to enable the engineer to duplicate the properties of some material that he knows by experience to be satisfactory for a particular service. This is exactly what is proposed in the use of a standard in the formula. Moreover, the worth of the standard may be expressed, not as a figure having no physical meaning, but as worth to the engineer.

In many cases this figure may be the maximum allowable fiber stress in the structure. In others it may be a figure that measures the ability to deform without rupture. For any given service there is a standard material for which there is an absolute worth to be assigned from experience. For any other material the physical properties of which are known, the absolute worth in terms of maximum allowable fiber stress, for example, may be determined from the formula. The test of any formula of the foregoing type is the nature of the results of its application, and the specific application which follows is submitted to illustrate how the formula may be used.

Here is a comparatively simple procedure by means of which engineers can select metals for equipment construction. A. B. Kinzel, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y., did a real service when he devised this method and presented it in a paper before the Aug. 27-30, 1928, meeting of the American Society of Mechanical Engineers, St. Paul-Minneapolis, Minn.

It is well known that for certain applications the data obtained from the tensile test are insufficient to determine whether or not the piece will be satisfactory in service, and a number of other tests have been devised. Of these the most usual are the bend, shock, hardness, Erichsen, fatigue, creep, wear and corrosion tests. The values obtained from these tests may be used in the general formula in exactly the same way as the four values obtained from the tensile test.

In many cases one or more of these physical-test values should be used in connection with the results of the tensile test, while in many other cases one or more of these physical-test values may be used in place of one or more of the values obtained from the tensile test. In the latter event, the formula may even be simplified, because basically we are generally dealing with only two classes of properties, strength and ductility. An example of such a simplification is the substitution of a quantitative bend test as devised by the author. ("A Critical Study of the Bend Test as Applied to Iron and Steel," A.S.S.T., Nov., 1927. "Bend Test of Welds," W. B. Miller, A.W.S., Nov., 1927.) This test is a measure of ductility and gives a value embodying properties represented by elongation and reduction of area, and may be used in place of both elongation and reduction of area in the formula.

In the consideration of strength the yield point is occasionally an unessential factor because it is generally sufficiently high compared to the ultimate strength and sufficiently dependent upon the ultimate strength so that it need not be considered independently of the ultimate strength. This makes it possible to set up a worth formula with only two terms, ultimate strength and bend elongation for certain applications. This has been carried out in the case of welded joints for pressure vessels and is discussed in the following.

The quantitative bend test, the results of which are used in the following application, consists essentially of bending the specimen in a vise or press by exerting a couple at the ends of the piece and avoiding the use of a tup, pin or other local application of force at the point of maximum bend. The fiber elongation at the outside of the bent sample at the point of initial fracture is measured. This is the figure used as a measure of the performance of the specimen on bending.

For welded joints in pressure vessels the modification of the foregoing formula is

$$\frac{w}{W} = \left(\frac{u}{U}\right)^n \left(\frac{b}{B}\right)^m$$

where B, b are the bend elongations.

If W be calculated as $U^n B^m$, a figure results which represents the worth, but which has no physical significance. By expressing worth in this case as maximum allowable fiber stress, the worth figure is immediately applicable. Let

7,700 lb. per sq.in. be the worth for 55,000 lb. per sq.in. strength and 10 per cent bend elongation, these being taken as mean standard conditions. These figures are gleaned from experience. It remains simply to evaluate by engineering judgment from experience the values of n and m. Other things being equal, the worth of steel for this type of service is directly proportional to the ultimate strength, so that n becomes 1.

The assignment of the numerical value to m is somewhat more difficult to obtain and requires the interpretation of engineering experience into mathematical terms. Consideration of allowable values for materials giving satisfactory service in this application indicates that the penalty for lack of ductility should vary as the cube root of the bend elongation. The cube root is indicated rather than the square root or the fourth root, as relative worths obtained with these exponents (see Table II) are not consistent with current safe practice. The general formula as given is entirely logical. The choice of actual numbers for the symbols therein represented is purely empirical, and in this case m is chosen as $\frac{1}{3}$. Perhaps $\frac{1}{3.1}$ or some other value close to $\frac{1}{3}$ would be equally suitable.

TABLE I—MAXIMUM ALLOWABLE FIBER STRESS

Per Cent Elongation by Bend Test	Ultimate Strength in Thousands of Lb. per Sq.In. 45	50	55	60	65	70	75	Factor of Safety Based on Ult. Str.
5	5,000	5,600	6,100	6,700	7,200	7,800	8,300	9.0
7½	5,800	6,400	7,000	7,700	8,300	8,900	9,600	7.8
10	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
12½	6,800	7,600	8,300	9,000	9,800	10,500	11,300	6.65
15	7,200	8,000	8,800	9,600	10,400	11,100	12,000	6.25
17½	7,600	8,400	9,300	10,100	11,000	11,700	12,700	5.9
20	8,000	8,800	9,700	10,600	11,400	12,300	13,200	5.7
22½	8,300	9,200	10,100	11,000	11,800	12,800	13,700	5.5
25	8,600	9,500	10,500	11,400	12,400	13,200	14,200	5.3

TABLE II—COMPARISON OF VALUES OBTAINED USING DIFFERENT EXPONENTS

Per Cent Elongation by Bend Test	Ultimate Strength in Thousands of Lb. per Sq.In. 45	50	55	60	65	70	75	Factor of Safety —
5*	4,450	4,970	5,500	5,950	6,450	6,950	7,500	10.0
	5,000	5,600	6,100	6,700	7,200	7,800	8,300	9.0
	5,300	5,950	6,500	7,100	7,600	8,250	8,850	8.5
7½	5,500	6,100	6,700	7,300	7,900	8,500	9,150	8.2
	5,800	6,400	7,000	7,700	8,300	8,900	9,600	7.8
	5,900	6,550	7,200	7,850	8,500	9,150	9,900	7.6
10	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
12½	7,100	7,800	8,600	9,400	10,200	11,000	11,800	6.35
	6,800	7,600	8,300	9,000	9,800	10,500	11,300	6.65
	6,700	7,400	8,150	8,900	9,650	10,400	11,200	6.7
15	7,900	8,800	9,700	10,600	11,500	12,300	13,200	5.7
	7,200	8,000	8,800	9,600	10,400	11,100	12,000	6.25
	7,100	7,800	8,600	9,400	10,200	11,000	11,800	6.35
17½	8,300	9,250	10,200	11,200	12,000	12,900	13,800	5.35
	7,600	8,400	9,300	10,100	11,000	11,700	12,700	5.9
	7,250	8,050	8,850	9,600	10,400	11,300	12,100	6.2
20	8,950	9,950	10,900	11,900	12,900	13,900	14,900	5.05
	8,000	8,800	9,700	10,600	11,400	12,300	13,200	5.7
	7,500	8,300	9,150	9,950	10,800	11,600	12,500	6.0
22½	9,250	10,500	11,500	12,600	13,600	14,700	15,800	4.75
	8,300	9,200	10,100	11,000	11,800	12,800	13,700	5.5
	7,700	8,600	9,400	10,600	11,200	12,000	12,900	5.8
25	10,000	11,100	12,200	13,600	14,300	15,500	16,600	4.5
	8,600	9,500	10,500	11,400	12,400	13,200	14,200	5.3
	7,950	8,800	9,700	10,600	11,500	12,300	13,200	5.7

*The numbers in the first line of each group of three lines are the values using the square root; those in the second line the values using the cube root; and those in the third line the values using the fourth root.

TABLE III—RESULTS OF APPLICATION OF FORMULA TO VARIOUS MATERIALS

Material	Ult. Str in M Lb./Sq.In.	Per Cent Bend Elongation	Worth Allowable Fiber Stress Lb./Sq.In.	Factor of Safety Based on Ult. Str.
Cast iron	20	0.2	750	27.0
Structural plate	60	23	11,000	5.45
Three per cent nickel plate	75	29	15,000	5.0
Boiler plate	50	100	15,000	3.3
Chrome-vanadium bar	220	10	35,800	7.15
Chrome-vanadium bar	135	31	27,500	4.9

Substituting the mean property values and exponents in the general formula, the specific formula becomes:

$$\frac{w}{7{,}700} = \frac{u}{55{,}000}\left(\frac{b}{10}\right)^{\frac{1}{3}}$$

$$\text{or } FS = \frac{u}{7.15}\left(\frac{b}{10}\right)^{\frac{1}{3}}$$

Table I shows the results obtained for maximum allowable fiber stress (FS) based on this formula.

It will be seen that the values in Table I are in accordance with good engineering principles and experience, indicating a satisfactory choice of standards and exponents. It is interesting to note the results of the application of the formula to a variety of engineering materials, as shown in Table III. Here it is assumed that the pressure vessel is jointless and is made of material having the properties indicated.

It is, of course, obvious that with the present state of the art, jointless pressure vessels of material having the properties of heat-treated chrome-vanadium bars cannot be made. The table serves merely to show how the formula would apply in extreme cases.

Quantity of Oil Required for Lubrication

By H. L. Kauffman

Petroleum Consultant, Denver, Colo.

HOW much oil should be required for the lubrication of compressors and vacuum pumps that employ mechanical force-feed lubricators?

In most cases compressors are overlubricated rather than underlubricated. This is likely to be detrimental instead of beneficial, as excessive lubrication is often responsible for the formation of troublesome deposits on the discharge valves and passages. When the intake air is not screened so as to exclude dust and other impurities, and if too much oil is being applied, the combination collects on the outlet valves and passages, where the warm compressed air bakes the mixture into troublesome deposits. If an oil of poor quality or of improper viscosity be used, it will accelerate the formation of deposits, especially when the intake air is unscreened.

In units comprising both gas-engine and compressor cylinders, it will generally be found that the compressor cylinder can be lubricated effectively on from one-tenth to one-fifth of the oil required for the gas-engine cylinder. This is because the operating temperatures in a compressor are moderate when compared with those of a gas engine. Operating temperatures in a vacuum-pump cylinder are also moderate. In lubricating a compressor cylinder a very sparing oil supply will form a tight piston seal, prevent blow-by and reduce deposits to a minimum, accomplishing this without in any way impairing the moving parts.

Below is a table that may serve as a guide in determining the quantity of oil ordinarily required for compressor and vacuum-pump lubrication. However, this should not be taken as definite, as speed and other factors affect the rate of oil feed. Furthermore, a solvent will have a diluting effect on the lubricant, in which case it may be necessary to increase the oil feed. The quantities shown are for average operating conditions and assuming screens to be used to insure clean air. These rates are for new installations and can be slightly reduced after the cylinders have been in operation for three or four weeks.

Size of Compressor or Vacuum Pump Cylinder	Oil Feed in Drops per Minute	Oil Feed per 10 Working Hours
10 x 20 in.	6 max.	0.2 pint
18 x 20 in.	9 max.	0.3 pint
24 x 36 in.	12 max.	0.5 pint

Safety Designed Into Electrical Structures

SAFETY for life, property and the continuity of service should be a quality inherent in all electric structures and, being a fundamental characteristic, can be engendered only as an element of design. This, said the speaker, did not mean hanging up rubber gloves, fire extinguishers and other devices of these classes.

The details of safety-feature design in one plant will not apply to all stations. These must be decided by the engineer in charge. The degree to which safety should be incorporated into the finished work must necessarily be tempered by the nature of the equipment, the importance of the installation, various local conditions and the funds available.

By the time the electrical engineer comes on the job, the steel engineers have arranged the steel as they think it should be and the concrete engineers have done similarly with their material. This may not be in the best interest of safety in the plant's operation. It is advisable for the electrical engineer to get on the job early in the design if the interests of safety are to be protected.

Possibility of fire is one of the first things to be considered. Oil and the battery room are sources of fire and explosion. Oil should be kept where it will do the least harm in case something happens. The battery room should be located where adequate natural ventilation can be had. If this cannot be done, proper artificial ventilation with fans must be provided. The battery-room lighting fixtures should be gas-tight to avoid the danger of explosion from an electric arc.

Emergency exits from the various rooms in the plant require careful study. These exits are usually arranged by the steel engineers, but the electrical engineer should look the plans over in the early stages of the design and make sure that adequate emergency exits are provided. Riot locks should be put on the doors so that if a man wishes to get out of a room in a hurry, he will have no difficulty opening the door.

The doors should be wide enough to allow machinery to be taken in and out easily; otherwise, emergency repairs and replacements may be seriously impeded.

Floor finish must be considered. Rubber-heeled shoes on an oily smooth-surfaced concrete floor may constitute a series of human hazards. Where floors are likely to be oily, they should have a rough surface. This also applies where ice may be present in the winter time, as in front of water-cooled transformers located out of doors.

Lighting, either natural or artificial, must be adequate. Artificial lighting is usually laid out on a basis of so many foot-candles per unit area, but this is wrong. The kind of equipment in a room should decide the amount and arrangement of artificial lighting. This applies also to natural lighting.

Emergency lighting should not be overlooked. Although it is desirable to have plenty of light in an emergency, it must be kept in mind that emergency lamps are usually supplied from the control battery. For this reason, their number should be kept to what is really necessary. During an emergency the control battery may be called upon to do a lot of extra switching. Therefore, it is objectionable to have it loaded with unnecessary lights.

Windows that open must not be located so that rain coming through them will wet equipment. Window operating wheels should not be placed near high-tension equipment.

Plenty of clearance should be provided around machines for making repairs. Conditions are frequently much more unfavorable for repairing machines than for making the original installation. If this matter is overlooked, it may seriously delay repairs when machines are required in a hurry.

Station piping systems give lots of food for thought. Bare cold-water piping on a hot day will sweat, therefore it should be insulated when installed. Where piping is carried over equipment, troughs should be provided under the piping or sheds above the equipment. When sheds are placed above electrical machines, their effect on the equipment's temperature should be kept in mind.

Metal straps should not be used to hold pipe insulation where there is danger of their coming off and falling on electrical equipment. Serious short-circuits have been caused by these straps.

Care should be given to the communication and signal systems. The communication system should be independent of any other. When something goes wrong it is generally required immediately. If it is tied up with outside calls, clearing the trouble on the power system and restoring service may be seriously delayed.

In combination with the signal system it is advisable to install a synchroscope at the machines. If a number of plants are operating in parallel and one is tripped off the system, the large block of load dumped on the other machines may pull their speed below the switchboard governor control. In such cases it will be impossible to synchronize the incoming machines from the switchboard. If a synchroscope is placed where the turbine engineer can see it, he can synchronize the machines from the throttle.

On rotating equipment, the greatest danger of damage is from fire and short circuits. Differential-relay protection will take care of short circuits and grounds on alternating-current generators, but a fire may have been started. If not extinguished immediately, it may cause extensive damage to the windings.

Some kind of fire-fighting equipment that can be quickly brought into action should be provided. There are a number of these systems. Some of them turn an inert gas into the machine, others use steam or water. Water appears to be severe treatment of the windings, but experience shows differently. In the discussion attention was called to a case where a fire started in a turbine-driven alternator. It was put out with steam and the machine put back into service immediately.

"THE Incorporation of Safety into Electrical Station Design" was the title of a paper presented by V. R. Bacon, engineer, United Engineers & Constructors, Inc., before the Philadelphia section of the Association of Iron and Steel Electrical Engineers, on March 2. This article is based on Mr. Bacon's presentation of his paper.

Recent Publications

The Profession of Engineering. By Prof. D. C. Jackson, Jr., and Prof. W. Paul Jones, University of Louisville. Published by John Wiley & Sons, New York City, 1929. Imitation leather; 5x8 in.; 124 pages. Price, $1.50.

THIS book will help the young man seeking guidance to an engineering career and will be read with interest by many already engaged in engineering work. The education and success of the engineer are discussed by Daniel Webster Mead. Herbert Hoover is represented by a brief but masterful essay on the engineer's contribution to modern life. The various branches are covered as follows: Civil engineering, George Fillmore Swain; Mechanical, George Hale Barrus; Mining, Robert Peele; Electrical, Harold Winthrop Buck. John Hays Hammond contributes essays on the electrical engineer and the chemical engineer.

Treatise On The Fundamental Cause of Disastrous Explosion of Steam Boiler. By Sojiro Haga, Chief Engineer. Published by the First Engine & Boiler Insurance Co., Ltd., No. 18, 1-Chome, Honzaimokucho, Nihonbashiku, Tokyo, Japan. Paper; 6x9 in.; 94 pages.

NO STATEMENT of price was received with this booklet, and it is presumably obtainable free on request by those interested. As is the case with much Japanese engineering literature, this is published in English. The author is desirous of receiving American comments on the unusual theories of steam boiler explosions he presents. An explanation of these theories (in non-mathematical language) occupies the first thirty pages. The body of the book is devoted to a résumé of a large number of boiler explosions, including excerpts from *Power* in the last ten years and reports of explosions in Japan. The latter part of the book is devoted to further explanations of the author's theories of boiler explosions.

Illustrated Technical Dictionaries. Edited by Alfred Schlomann. Published by V D I—Verlag, G.M.B.H., Berlin, NW. 7, Germany, 1928. Distributions for Great Britain and the British Empire, Lewenz & Wilkinson Ltd., 25 Victoria St., London, S. W. 1, England. Cloth; 7½x10 in.; 3,965 illustrations; 1,304 pages.

IN THIS volume various electrical terms are presented in six languages. These are given in German, English, Russian, French, Italian and Spanish, the translations appearing in the order named. This is the second edition of this work, and it has been completely revised to bring it up to date and two new sections have been added, one on Electrical Jurisprudence and one on Electrical Economics. These sections will be of particular value in connection with questions that arise at World Power Conferences and other international engineering organization meetings.

Other subjects included are fundamentals of electrical engineering; electrical and magnetic measurements; electrical machines, both direct and alternating current; materials used in electrical work; electro-optical applications; electricity for medical purposes, electro-chemistry; storage batteries and other subjects in the field of electrical engineering and electro-chemistry. Each item is indexed in the six languages of the translations, thus making the different words and phrases easily located. The completeness of this index is indicated by the fact that it comprises over 500 pages.

The Technology of Low Temperature Carbonization. By Frank M. Gentry. Published by Williams & Wilkins Company, Baltimore, Md., 1928. Cloth; 6x9 in.; 80 illustrations; 399 pages. Price, $7.50.

CARBONIZATION of bituminous coals at low temperatures is apparently just at the threshold of commercial development in the United States. Years of investigation and large expenditures for experimental plants are beginning to bear fruit. Some apparently successful installations are reported, while others of great promise are being built.

This is important to the field of power generation, for the process holds forth the possibility of improving the grade of boiler fuels, while at the same time obtaining byproducts in the form of gas and tar that pay for the process, or even yield a profit. Raising the grade of coals promises to make readily available, in almost all parts of the country, boiler fuels equal or superior to the natural high-grade steam coals so sought after today. It also promises more than that, for the coke or char from the low temperature process has a greater reactivity than most natural coals, thus permitting larger quantities of it to be burned per square foot of grate area per hour. The resulting increase in heat release from a given size of grate promises to yield increased steam capacity per unit of boiler size.

In view of these facts that cause power engineers to take an increasing interest in low temperature carbonization, Mr. Gentry's book is particularly welcome at this time. So far as the writer is aware, the volume is the first in English to treat the theory of the process adequately. Fully half the book is devoted to these technical studies, covering the fundamentals and the gas, tar, coke and other products of the carbonization.

A brief résumé of processes is given, but this part of the work is a distinct relief from other works, which have piled process description on description, much to the reader's discomfort. Operation, design and materials are briefly treated in a chapter which closes with a concise but helpful discussion of the heating of retorts and the theory of heat transfer.

A final chapter discusses the economics of the process and the market prospects of its products. In conclusion the possibilities of the combination of low-temperature carbonization with steam generating stations are pointed out and evaluated. An extensive bibliography is a particularly useful portion of the volume.

There is a likelihood that power engineers will soon have to go extensively into the study of low-temperature carbonization, for many plants will consider its adoption. These engineers can make no better beginning of their study than to digest the contents of Mr. Gentry's work and follow his methods in their investigations.

Aluminum Busbars, a bulletin issued by the Aluminum Company of America, Pittsburgh, Pa., is a compilation of data on the use of aluminum in busbar structures. Copper is the material generally thought of as being used for busbars in power plants and substations. This bulletin shows that some of the outstanding busbar structures have aluminum conductors. The subject of busbar application is discussed for three conditions—stations supplying high-voltage networks, stations supplying moderate-voltage networks and direct-current stations. Methods of calculating the carrying capacity of aluminum busbars for both direct and alternating current is given and also the carrying capacity of joints. Specifications for flat and tubular busbars and a number of tables are included. Those interested in busbar structural design will find this bulletin a useful piece of engineering literature to place in their libraries.

A Survey of the New Orleans Industrial Zone is the name given a 50-page booklet published by the National Advertising Committee, New Orleans Association of Commerce, New Orleans, La. In this booklet is presented information concerning the City of New Orleans and the advantages it offers for manufacturing and distribution. Data are given on markets, domestic and foreign; natural resources and raw materials; manufacturing facilities, labor and labor laws; transportation; Louisiana corporation laws; climate and other subjects. Several commercial maps are also included, which show the industrial relation of New Orleans to the United States and to other countries.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Pacific Gas & Electric Company to Install 1,400-lb. Units in San Francisco Station

Capacity of Old Station "A" to Be Raised to 225,000 Kw. During Next Five Years

THE Pacific Gas & Electric Company has announced plans for the enlargement of Station "A" in San Francisco, the work to begin at once. When completed the new Station "A" will be the largest electric generating plant on the company's system. It will be operated by steam and will cost more than $11,000,000.

The new plant will go into Station "A" in the Potrero section of the city, and will be rebuilt and converted from 64,000 into 225,000 kw. At the present time the largest plant on the P. G. and E. system is Pit No. 3 on the Pit River in northern California, rated at 82,000 kw. New Station "A" will be almost three times as large.

The plant will be built in units and will take five years to finish. Work on the first units, two 52,500-kw. steam-turbine generators, will begin at once. Three large boilers are being designed to supply steam for these units. The boilers will operate at 1,400 lb., the highest pressure yet applied on the Pacific Coast. It will take a smoke-stack 24 ft. in diameter and 200 ft. high to carry off gases from the boilers.

The first unit will be placed in operation early in 1930. The second unit, of the same rating as the first, will be ready six months later. Combined, the two units will cost five and one half million dollars. When this work is completed, the station, with changes in some of the old machinery, will have a capacity of 131,000 kw. Other units will go in as fast as needed and at the end of 1934 the station will measure up to 225,000 kilowatts.

Steam-electric plants have doubled in efficiency in the last ten years, and where 230 kw.-hr. of electric energy were formerly possible to a barrel of oil, 460 are now being produced.

Like its predecessors, the new station will be used to make up shortages in water power and to stand by for emergency service in case lines go down or mountain plants fail. It will also be used to produce base load, for its production costs will be very low.

In addition, the new station will assure an ample supply of power for the commercial and industrial growth which lies ahead for San Francisco and the peninsula as far south as San Jose.

A.S.R.E. Corrosion Committee Reports Successful Tests

In a recent report of the special committee on corrosion, of the American Society of Refrigerating Engineers, a record of research and test results on both brine systems and condenser problems was given. It was stated that the American Ice Company had made extensive use of these results at a very great saving in replacements of ice cans. This company employs a special engineer to apply proper methods to its plants. Treatment is started before the cans are first immersed or before the operation of a new plant begins.

The method of treatment with inexpensive chemicals must begin promptly, says the report, because half the protection of a new can may, in certain cases, be destroyed in the first two days of use. When these methods are put in wider application they may mean enormous savings to the ice industry by lengthening the life of the ice cans and the tank coils. The chemicals recommended are inexpensive and can be obtained at any drugstore, although when used in large quantities they should be ordered from a refrigeration supply house or from a chemical house.

The latest recommendations from the brine system phase of the committee's work, follow:

"During the past two years a large number of both old and new brine tanks have been treated with dichromate and caustic soda, as recommended. Many of these treatments have been followed by corrosion tests and by brine analyses. As a result of these and other tests and observations, the following conclusions have been drawn:

"1. When the concentration of sodium dichromate is maintained at 100 lb. per cu.ft. of calcium brine (200 lb. per 1,000 cu.ft. per sodium brine) and the *pH* maintained at 7.5 to 8.5 (slightly alkaline) there will be very little corrosion of either bare or galvanized steel or iron.

"2. It is necessary to add about one half the original amount of dichromate each year and to add sufficient caustic soda or lime to maintain the brine slightly alkaline. It is advisable to have an analysis of the brine made at least once a year.

"3. No instance of any harmful effect resulting from the dichromate treatment has been found.

"4. The sodium phosphate treatment will give good results, but the necessity of close control of brine conditions causes the treatment to be of little practical use."

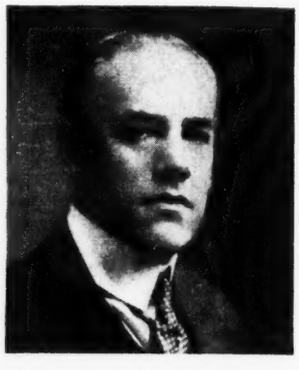
Those interested in this report may obtain a copy from the A.S.R.E., 27 W. 39th St., New York City.

Southern Textile Show Date Announced

The ninth Southern Textile Exposition will be held in Greenville, S. C., in October, 1930, it has been announced by William G. Sirrine, president of the exposition organization. More than one hundred applications have been received already, he said.

The prospectus will be issued in the early fall. So many exhibitors have applied for their former locations that little change will be made in the diagram of space on the first floor. Some changes may also be made in other parts of the hall. The Annex will also be used. The Exposition will be under the personal direction of Mr. Sirrine, president, assisted by the secretary, Miss B. M. Green, and a staff of assistants.

Men in the News



JOHN E. ZIMMERMANN

who has just been elected president of the United Gas Improvement Company, of Philadelphia. He has been prominent in Philadelphia engineering circles for many years and was a founder, with Charles Day, of the engineering and construction firm of Day & Zimmermann, which is at present a subsidiary of the United Gas Improvement Company

Spot * News

ELECTRIC ROOM COOLERS *are among the latest refrigerating inventions to be offered to the public. They look like phonographs, it is said, and are simply used as the reverse of stoves. The refrigerating principle is similar to that of other types of household units presumably.*

* * *

VIRGINIA'S HYDRO RESOURCES *are placed at 459,000 hp., available 90 per cent of the time. The 50 per cent figure is 812,000 hp. The state's developed hydro resources on Jan. 1 were 141,500 horsepower.*

* * *

UNITED STATES ARMY ENGINEERS *have recently made a preliminary survey of the Rappahannock and Potomac Rivers with a view to possible power development. No figures are disclosed, but it is understood that large projects on these streams have been found feasible.*

* * *

A PROPOSED MERGER *of utility interests in Vermont has been argued before the state Public Service Commission, and has developed little opposition, it is said. The new concern would be known as the Central Vermont Public Service Company and would represent $15,000,000 of capital.*

* * *

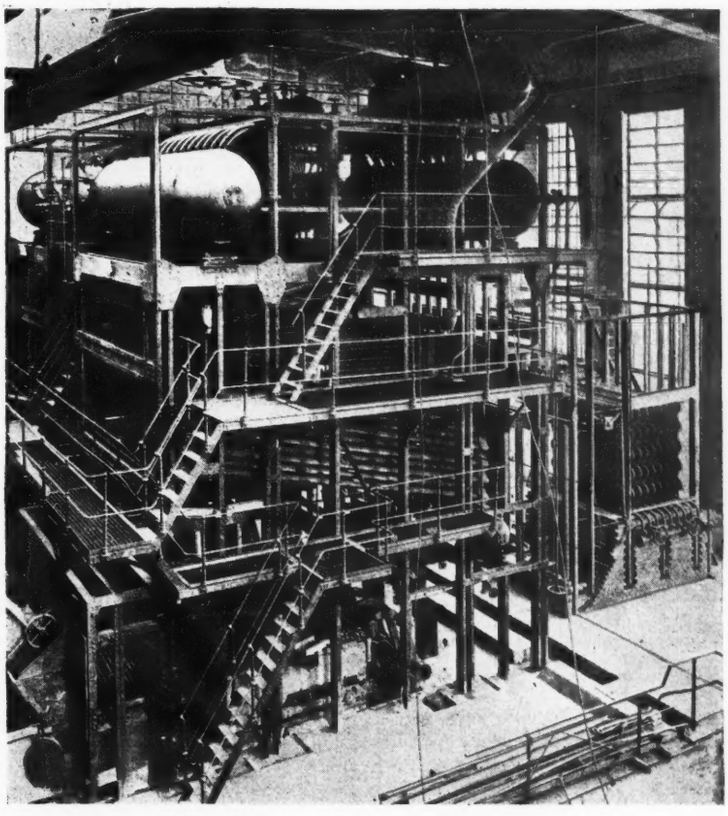
ONE OF THE PROBLEMS *reported from the Charles R. Huntley station at Buffalo, N. Y., is the freezing of coal in railway cars in winter. A thawing shed has been fitted, which will loosen up the coal in six gondolas at a time. The cars are left in the shed overnight.*

* * *

THE GATINEAU POWER COMPANY *has put two new generators on the line at its Farmers and Chelsea plants, north of Ottawa, Canada. The addition increases the output of the two plants by 58,000 hp., and brings the total of this system, owned by the International Paper Company, to 232,000 kilowatts.*

* * *

THE HOLSTON RIVER PROJECTS *in eastern Tennessee have hit a snag since two separate companies have appeared before the Tennessee public utility commission with requests for permits to undertake the work. For the time being at least, the center of the stage will be surrendered by the engineers to the lawyers in the case. The plans for the development of the two interested parties are substantially the same.*



THIS 3,866-sq.ft. German boiler is designed for a working pressure of 425 lb. per sq.in. Note the one-piece boiler drums and the large-diameter boiler tubes, which in American practice, would be unusual. The boiler is installed at the Mannesmann Tube Plant, Glesenkirchen, Germany.

Tokyo Engineering Delegates To See America First

An itinerary covering the trip of the American delegates to the World Engineering Conference in Tokyo, Japan, in October has recently been proposed by the American Committee, and will cover a little over a week, during which time members of the party will visit several points of scientific and scenic interest before embarking for Japan at San Francisco.

As outlined in a communication from the committee the itinerary calls for a start from New York City on Oct. 2. About 24 hours will be spent in Washington, D. C., during which time the delegates will be entertained at the White House by the President, and will have an opportunity to make short excursions in and around the nation's capital. After leaving Washington, several hours will be spent in Chicago before embarking by the Santa Fe route for California.

A stop of eight hours will next be made at the Grand Canyon, where motor and horseback and possibly airplane trips will be arranged. On Oct. 8 the party will arrive at Los Angeles and will visit the laboratories of the California Institute of Technology to be the guests of Dr. R. A. Millikan. A visit will also be made to the Mt. Wilson observatory. Later there will be an opportunity to see many of the show places in the vicinity of Los Angeles. The party will leave the city for the north on Oct. 9.

En route to San Francisco the delegates will stop at Leland Stanford University, after which they will motor to the city and will spend Oct. 10 visiting some of the famous places of interest around the Golden Gate.

On Oct. 11 the party will go aboard the steamship "President Jackson" which will sail for the Orient at 2 p. m.

For those not wishing to occupy a week in sightseeing, a direct trip across the country will be arranged, and members of this party will join with the other delegates in the reception features to be extended at Chicago and San Francisco. Local entertainment committees in New York, Washington, Chicago, Los Angeles and San Francisco will receive the delegates on their arrival and will be prepared to give information and to render any assistance desired. A general information office for American and foreign delegates will be maintained in New York City at the Engineering Societies Building, 29 West 39th St.

Obituary

Fred L. Johnson, a former member of the editorial staff of *Power* and for many years active in the affairs of the National Association of Power Engineers died at his home in Brooklyn, N. Y., on Feb. 20 at the age of 68. Mr. Johnson was at one time chief operating engineer of the Lynn (Mass.) Gas & Electric Company. Later he was affiliated with *Power* as editor of the inquiries page, and subsequent to that, held the position of operating engineer of the McGraw-Hill Building in New York City. At the time of his death Mr. Johnson was secretary of an apartment house corporation in Brooklyn, and was acting as its chief operating engineer.

Coming Conventions

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Big Wind Inn, Lake of Bays, Ontario, Can., June 27-29. F. L. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

With the Society Sections

A. I. E. E., Regional Meeting, at Cincinnati, Ohio, Mar. 20-23, at the Hotel Gibson. Technical program and elaborate entertainment plans.

A. S. M. E., Boston Section. Meeting Mar. 19. Subject: "The Crankless Engine," by A. G. M. Michell.

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Philadelphia Section. Meeting Mar. 26. Subjects: "Resume of High Steam Pressures as Used in Industrial Plants," P. W. Swain. "Twelve-hundred Pound Holland Station of the Pennsylvania and New Jersey Power System," by E. M. Gilbert, W. S. Barstow Management Association, Reading, Pa. Second Paper: "A Resume of Industrial Power Plants Using High Steam Pressures," by P. W. Swain, Associate Editor, Power.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Florida Section. Meeting, April 10, at Jacksonville, Fla. Subject to be announced later.

Engineers Club of St. Louis. Meeting, Mar. 13. Subject: "The Automatic Control of Combustion in Boiler Furnaces," by Mellville Stein, Leeds & Northrup Co., Philadelphia, Pa.

Second Annual Indiana Fuel Conference, at Purdue University, Lafayette, Ind., April 4-5.

Personals

T. G. Dalton, formerly of the National Boiler Washing Company, The Adams Express Company and the United States Reclamation Service, respectively, has accepted an appointment as sales representative of the Railway Engineering Equipment Company, Railway Exchange, Chicago, Ill.

Roy V. Wright was re-elected president of the United Engineering Society, and Francis Lee Stuart was re-elected as vice-president, at the annual election of the trustees on Jan. 24.

W. H. Brand has been elected a director of the Interstate Drop Forge Company, which is affiliated with the Chain Belt Company, of Milwaukee, Wis.

R. F. Crego, formerly sales manager of the L. C. Smith Bearing Company, has recently joined the sales organization of Foote Bros. Gear & Machine Company, Chicago, Ill.

William J. Hanley, manager of the East Central District of the General Electric Company, with headquarters in Cleveland, and Charles K. West, manager of the Atlantic District, with headquarters in Philadelphia, have been elected vice-presidents in charge of the commercial activities of the company in their respective districts.

Business Notes

Air Preheater Corporation has removed its main office from 25 Broadway to 40 East 34th St., New York City.

The Murray Iron Works Company, of Burlington, Iowa, announces the appointment of the C. B. Davis Engineering Company, Brown-Marx Building, Birmingham, Alabama, and Flickinger, Meyers & Rudolph, 129 W. Second St., Los Angeles, as its district turbine sales representatives.

The Heat Transfer Products Company, of 90 West St., New York City, announces that it has become affiliated with the American Locomotive Company, with offices at 50 Church St., New York City.

The Chicago-Jefferson Fuse & Electric Company has changed its name to the Jefferson Electric Company

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	$1.25@1.06
Smokeless	Cincinnati	2.15@ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.55@ 1.75
Gas Slack	Pittsburgh	.90@ 1.10
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.00@ 1.50

FUEL OIL

New York—Mar. 7, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis—Feb. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.45 per bbl. or 42 gal.; 26@28 deg., $1.50 per bbl.; 28@30 deg., $1.55 per bbl.; 30@32 deg., $1.60 per bbl.; 32@36 deg., gas oil, 4.78c. per gal.; 38@40 deg., distillate, 5.98c.

Pittsburgh—Feb. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia—Feb. 27, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati—Mar. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Mar. 2, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Mar. 4, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.52c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Mar. 2, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

with offices at 1500 South Laflin St., Chicago, Ill.

THE TRIMONT MANUFACTURING COMPANY, of Roxbury, Mass., has purchased the Stillson wrench business of the Moore Drop Forging Company, of Springfield, Mass. The Trimont company will continue the manufacture of both the Original Pattern and Popular type of Stillson wrenches.

THE BROWN INSTRUMENT COMPANY, Philadelphia, Pa., has recently changed its Buffalo office from 624 Ellicott Square to 402 Marine Trust Building.

MCCLAVE-BROOKS COMPANY, Scranton, Pa., announces the change of its Buffalo District office from 333 Jackson Building, to 301 Jackson Building, Buffalo, N. Y.

THE PREST-O-LITE COMPANY, INCORPORATED, of 30 East 42nd St., New York City, has acquired the business of the Acetylene Products Company, whose two plants operated at 401 E. Buchanan St., Phoenix, Ariz., and at 914 Texas St., El Paso, Texas.

TRADE CATALOGS

PRESSURE VESSELS—The Linde Air Products Company, New York City, has issued an eight-page booklet on "Oxwelding Pressure Vessels," which is reprinted from the January issue of their monthly publication, *Oxy-Acetylene Tips*. It is illustrated.

BOILER WATER CONCENTRATIONS—A twelve-page treatise, that is illuminated with charts and photographs, on "Control of Boiler Water Concentration," has been published by the Elgin Softener Corporation, of Elgin, Ill.

ELECTRIFICATION—The electrification on the New York Central Railway lines is the subject of the attractive, 34-page booklet recently published by the General Electric Company, Schenectady. There are photographs of exteriors and interiors of plants and equipment six wiring diagrams and several pages of engineering data.

ELECTRIC MOTOR DRIVES—Two leaflets, of four pages each, numbered GEA-1082 and 1083, concerning applications of the drives to cotton cards and for spinning and twisting frames, respectively, have been put out by the General Electric Company, Schenectady, N. Y. They are both illustrated.

CIRCUIT BREAKERS — The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., devotes eight pages, in a recent circular, No 1804, to Types 0-31 and 0-441 Oil Circuit Breakers. It also contains illustrations and diagrams.

TUBE COUPLINGS—The Parker Appliance Company, Cleveland, Ohio, explains and illustrates its tube couplings in a twenty-page booklet, Form No 2-1029.

VALVE CONTROL—A second edition of "Modern Valve Control Practice" has been issued by the Cutler-Hammer Manufacturing Company, of Milwaukee Wis. This contains much additional interesting information and many new illustrations.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Modesto—Swift & Co., Pacific and Davis Sts., San Francisco, is having plans prepared for the construction of a packing plant, to include refrigeration plant here. Estimated cost $75,000.

Conn., New Haven—United Illuminating Co., 84 Temple St., awarded contract for a 4 story, 150 x 160 ft. addition to power plant on Grand Ave., to Dwight Building Co., 69 Church St. Estimated cost $1,000,000.

D. C., Washington—Downtown Market, J. Wells, Pres., c/o E. Jarvis & Sons, Centre Market, is having plans prepared for the construction of a market building including refrigeration system, etc., at New York Ave. between 9th and 14th Sts. N. W.

Ga., Atlanta—Agnes Scott College, Decatur, is having plans prepared for the construction of a power plant, etc. Robert & Co., Bona Allen Bldg., are engineers.

Ga., Valdosta — Georgia Power Co., 75 Marietta St., Atlanta, awarded contract for the construction of an ice plant here, to J. P. Jones, St. Petersburg, Fla.

Idaho, Sandpoint—City Council, plans an election to vote $300,000 bonds for the construction of a municipal power plant.

Ill., Chicago—Chicago City Bank & Trust Co., 6233 South Halsted St., is receiving bids for the construction of a 6 story bank and office building at Sixty-third and Halsted Sts. Estimated cost $1,000,000. A. Epstein, 2001 West Pershing Rd., is architect.

Ill., Chicago—R. De Goyler & Co., 307 North Michigan Ave., Archts., is receiving bids for a 21 story apartment building including steam heating system, etc. at Division and State Sts. for Whitney-KleKamp Corp., 180 North Michigan Ave. Estimated cost $1,125,000.

Ill., East Moline — Peoples Power Co., R. B. MacDonald, Mgr., Rock Island, plans the construction of a new electric substation, also transmission line from Riverside power station to here.

Ind., Gary—Bd. of Education, is receiving bids until Apr. 9, for the construction of a high school including two swimming pools, etc. Estimated cost $700,000. W. B. Ittner, 911 Locust St., St. Louis, Mo., is architect.

Ind., Indianapolis—Indianapolis Power & Light Co., Monument Circle, is having plans prepared for the construction of a super power electric light plant at Troy Ave. Estimated cost $16,000,000. E. G. Ralston, Monument Circle, is engineer.

Ia., Ottumwa—City plans the construction of a hydro-electric plant and dam on Des Moines River. Estimated cost $775,000. Brown & Cook, 106 North Market St., are consulting engineers. J. T. Brady is city engineer.

Me., Old Town — Water District Commission received lowest bid for the construction of a pumping station and filtration plant from A. Bartington, 1 Washington St., Boston. Estimated cost $50,000.

Md., Baltimore—Mayor and City Council, City Hall, plans the construction of a central pumping station at Druid Hill Park. Estimated cost $600,000. E. G. Rost, Municipal Office Bldg., is engineer.

Md., Baltimore—United Railways & Electric Co., Court Square Bldg., will build a sub-station at White and Glen Oak Ave. Estimated cost $135,000.

Mass., Andover—Bd. of Selectmen plans additions and alterations to pumping station, including new steam pumping equipment. Estimated cost $50,000. Engineer not selected.

Mass., Bridgewater — Bd. of Education, State House, will receive bids until Mar. 20 (extended date) for rebuilding power house at State Normal School. Estimated cost $80,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer.

Mass., Nantucket—Lynn Gas & Electric Co., Exchange St., is receiving bids for the construction of addition to turbine room. Private plans.

Mass., Plymouth—Water Dept., plans the construction of a pumping station on Billington St. Private plans.

Minn., Minneapolis—Anderson & Nelson Construction Co., 2801 Park Ave., plans the construction of a 6 story apartment hotel, including steam heating and electric refrigeration systems, elevators, etc., at 26th St. and Park Ave. Estimated cost $1,500,000. M. G. Lindquist, 207 Security Bldg., is architect. Work will be done by owner's forces.

Neb., Wahoo—City is having plans prepared for extension and improvements to electric light plant. Burns & McDonnell, 401 Interstate Bldg., Kansas City, Mo., are engineers.

N. J., Allendale—Bd. of Council, Boro Hall, plans the construction of a pumping station. Estimated cost $25,000. Engineer not announced.

N. J., Asbury Park—C. E. Van Wickle, 501 Grand Ave., is receiving bids for the construction of an 11 story apartment building, including steam heating and refrigeration systems, boilers, elevators, etc., at Grand and 4th Aves. Estimated cost $500,000. E. H. Schmieder, Third Ave., Spring Lake, is architect.

N. J., Belleville—Bd. of Chosen Freeholders, Hall of Records, Newark, will receive bids until April 4 for the construction of a hospital, nurses home, etc., including steam heating, ventilation and refrigeration systems, etc., here. Estimated cost $1,000,000. Sutton & Sutton, 402 Broad St., Newark, are architects. Runyon & Carey, 31 Fulton St., are consulting engineers.

N. J., Elizabeth—West Jersey Corp., 208 Broad St., awarded contract for the construction of a utilities building at 16 West Jersey St. to A. A. Arace & Sons Inc., 640 3rd Ave. Estimated cost $150,000.

N. J., Elizabeth—White Ice & Supply Co., c/o W. Clifford, Jr., 293 Morris Ave., awarded contract for the construction of an ice plant at South 7th St. and Elizabeth River to Shore Construction Co., 94 Christie St., Newark. Estimated cost $50,000.

N. J., Englewood — Englewood Hospital, Engle St., plans addition to hospital. Estimated cost $1,000,000. Architect not selected.

N. J., Mount Mitchell — Syndicate, T. Mason, Pres., c/o H. H. Marshall, 37 West 43rd St., New York, N. Y., Archt. and Engr., is having preliminary plans prepared for the construction of a 6 story hotel including steam heating system, etc. here. Estimated cost $2,500,000.

N. Y., Binghamton — Our Lady of Lourdes Memorial Hospital, 160 Riverside Dr., had plans prepared for the construc-

tion of a hospital, nurses home, power plant, etc. Murphy & Lehman, 208 Livingston St., Brooklyn, are architects.

N. Y., Dundee—Bd. of Trustees will receive bids until Apr. 3 for the construction of a waterworks and sewage systems, including well, pump house, etc. William T. Field Engineers, Inc., Watertown, are engineers.

N. Y., New York—Bethlehem Engineering Corp., 1560 Broadway, will build a 54 story office building at 5th Ave. and 34th St. Estimated cost $18,000,000. Shreve & Lamb, 7 East 44th St., are architects. Work will be done by separate contracts. Undecided whether power unit will be contained.

N. Y., New York—Hotel Pierre Corp., c/o C. Pierre, 290 Park Ave., awarded contract for the construction of a 40 story hotel at 5th Ave. and 61st St. to George A. Fuller Co., 949 Broadway. Estimated cost $15,000,000.

N. Y., Palmer—New York Power & Light Corp., C. Miller, Purch. Agt., 126 State St., Albany, plans the construction of a hydro-electric plant on Palmer Falls. Estimated cost $3,500,000.

N. C., Monroe—Seaboard Air Line R.R. Co., Union Station, Savannah, Ga., plans the construction of a power house here. Private plans.

O., Cleveland — Cleveland, Cincinnati, Chicago & St. Louis Ry. Co., 230 East 9th St., Cincinnati, plans addition to roundhouse, power house, etc., at Linndale yards here H. Baldwin is chief engineer.

O., Cleveland — Cleveland Electric Illuminating Co., W. H. Harman, Purch. Agt., Illuminating Bldg., is receiving bids for the construction of a sub-station at 3600 Ridge Rd. Estimated cost $40,000. Private plans.

Pa., Pittsburgh—The Bell Telephone Co., 416 7th Ave., is having plans prepared for the construction of a 23 story addition to office building on Cherry Way. Estimated cost $1,500,000. J. T. Windrim, Commonwealth Bldg., Philadelphia, is architect.

Texas — Dutch Shell Pipe Line Co., c/o Roxana Petroleum Co., McCamey, awarded contract for electrification of oil pipe line to be built between McCamey and Houston, consisting of three stations along the line, doubling capacity of stations at McCamey and Irean to West Texas Utilities Co., Abilene. One or two 600 hp. electric pumps will be installed in each station.

Tex., Beaumont — M. F. Yount, c/o Yount-Lee Oil Co., San Jacinto Life Bldg., is having preliminary plans prepared for the construction of a 50 story hotel at Orleans and Wall Sts. Private plans.

Tex., Corsicana — Kennemer Bros. awarded contract for the construction of a 25 ton ice plant to J. E. Metcalfe & Son. Estimated cost $32,000.

Va., Radford — Appalachian Electric Power Co., subsidiary of American Gas & Electric Co., 30 Church St., New York, N. Y., authorized the construction of a hydro-electric power development, 80,000 kw. capacity on New River near here. Estimated cost approximately $11,000,000.

Va., Waynesboro—Central Atlantic States Service Corp., 1060 Broad St., Newark, N. J., is having plans prepared for the construction of a cold storage plant here. Estimated cost $250,000. Watsen Engineering Co., 140 Cedar St., New York, N. Y., is engineer.

Wash., Tacoma—Dept. of Public Utilities, I. S. Davison, Comr., plans the construction of a power development on the Nisqually river to generate 300,000 hp. Plans include four separate power plants and a dam, 1,600 ft. long across the top and 250 ft. high, near La Grande. Estimated cost approximately $25,000,000. J. L. Stannard is chief engineer.

Ontario—Dept. of Public Works, Toronto, plans the installation of a cold storage plant at Ottawa Hospital, Ottawa, $20,000, also automatic telephone system at Brockville, $60,000.

Ontario — Ontario Hydro-Electric Power Commission, 190 University Ave., Toronto, plans the construction of a new 110 kv. transformer station at Smith Falls, $80,450, also transformer station on Carling Ave., Ottawa, $200,000; 110 kv. transmission line from Gatineau electric plant, $113,500 and transmission line on Preston St. $50,000.

Ont., North Bay—City plans waterworks improvements including filtration plant, electric centrifugal pumps, etc. Estimated cost $300,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are consulting engineers. F. G. Mackie, City Hall, is city engineer.

Ont., Walkerville — Walkerville Electric System, is having plans prepared for addition to electric sub-station to include additional transformers, on Walker Rd. Estimated cost $70,000. D. B. McColl, c/o owner, is engineer.

Ont., Windsor — Bell Telephone Co. of Canada, 118 Notre Dame St., Montreal, Que., awarded general contract for the construction of a 6 story telephone exchange on Goyean St. to W. H. Yates Construction Co., 17 Main St. Estimated cost $500,000. Steam heating system, elevators, etc. will be installed.

Ont., Windsor — F. W. Martin, Wyandotte and Ouellette Ave., is having plans prepared for a 16 story office building, including steam heating system, etc., at Ouellette Ave. Estimated cost $1,500,000. Dangerfield & Winter, Huron and Erie Bldg., are architects.

Ont., Windsor—Merlo, Merlo & Ray, Sandwich St., Ford, will receive bids in April for the construction of a 16 story office building including steam heating system, elevators, etc. at London and Willard Sts. here. Estimated cost $1,000,000, Pennington & Boyde, Security Bldg., are architects.

Que., Hull—City Council, plans the construction of a municipal power house at Burey Creek. Estimated cost $50,000.

Que., Montreal—Corporation of Montreal plans the construction of a civic light plant alongside aqueduct canal. Estimated cost $2,000,000.

Equipment Wanted

Boilers—Charity Hospital, Tulane Ave., F. W. Matthews, Secy., New Orleans, La., will receive bids until Mar. 26 for three high pressure boilers and equipment for power house.

Boiler, Oil Burners and Automatic Control Equipment—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of a boiler, oil burners and automatic control equipment in Navy Yard, Mare Island, Calif.

Condenser and Switchboard—J. S. Bicknell, Clk., Columbia, Mo., will receive bids until Apr. 3, for 5,000 kva. turbine condenser and 14 panel switchboard, etc., for proposed power plant improvements.

Electrical Equipment—Utilities Commission, Utilities Bldg., London, Ont., electrical equipment to cost $75,000 including two 1,500 kva. transformers, etc. for proposed new sub-station.

Pump—B. J. Firminger, Clk., Beverly Hills, Calif., will receive bids until Mar. 19 for a deep well turbine pump for proposed waterworks improvements.

Pump — Bd. of Selectmen, Uxbridge, Mass., plans to purchase a motor driven pump for pumping station.

Pump and Motor—City of Ardmore, Okla., is in the market for an 800 g.p.m. centrifugal pump and 100 hp. motor for waterworks.

Pumping Equipment—Constructing Quartermaster, War Dept., Mt. Riley, Kan., will receive bids until Apr. 2, for pumping equipment.

Pumping Equipment, etc.—City of San Marcos, Tex., pumping equipment, etc., for proposed waterworks improvements. Estimated cost $45,000.

Pumps—City of Beaumont, Tex., J. W. Anderson, Mgr., plans to purchase one 2,500,000 g.p.d. high pressure pump and one 3,000,000 g.p.d. low service pump for proposed waterworks improvements. Estimated cost $33,000.

Pumps—Cities of Virden and Girard, Ill., will receive bids until Mar. 28 for four 700 g.p.m. and one 2,400 g.p.m. motor driven pumps for proposed waterworks improvements. Estimated cost $225,000.

Pumps—Village of Stirling, Ont., plans to purchase pumps, etc. for proposed improvements to waterworks and sewage systems. Estimated cost $70,000.

Pumps, etc.—City of Newton, Kan., new pumps, etc., for proposed sewage treatment work. Estimated cost $69,000.

Transformers, etc. — Kitchener Public Utilities Commission, V. S. McIntyre, Mgr., Kitchener, Ont., plans to purchase three 500 kva. transformers, 4,000 to 110 or 500 v. line transformers, etc., for electric light and power plant. Estimated cost $36,400.

Industrial Projects

Conn., Hartford—SERVICE BUILDING—Hartford Electric Light Co., S. Ferguson, Pres., Pearl St. will receive bids until Mar. 15, for the construction of a 4 story, 160 x 180 ft. service building on Sheldon St. Estimated cost $400,000. Smith & Bassette, 36 Pearl St., Hartford, are architects. E. W. Wiggin, 113 Church St., New Haven, is engineer.

Conn., Milford—RIVET FACTORY—Wright & Corson Co., 71 Charlotte St., Bridgeport, awarded contract for a 1 story, 25 x 112 and 155 x 250 ft., rivet factory at Milford Turnpike to W. J. Shaugnessy, Jr. Inc., 119 Fairfield St., Bridgeport. Estimated cost $300,000.

Ill., Chicago—RUG FACTORY—F. E. Davidson, 53 West Jackson Blvd., Archt., is receiving bids for a 6 story, 180 x 300 ft. factory at Diversey and Crawford Aves., for Olson Rug Co., 2809 North Crawford St. Estimated cost $1,000,000.

Ind., Gary—STRIP MILL—Illinois Steel Co. is having plans prepared for the construction of a strip mill in connection with steel mill. Estimated cost $5,000,000. Private plans.

Mich., Dearborn—BEDDING FACTORY—Peoples Outfitting Co., Michigan Ave., plans the construction of a 1 and 2 story factory. Estimated cost $200,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Ecorse — STEEL PLANT and POWER PLANT—Great Lakes Steel Corp., c/o G. R. Fink, Michigan Steel Corp., 1212 Book Bldg., Detroit, plans the construction of a steel plant, including power plant here. Estimated total cost $20,000,000 Private plans. Equipment for the manufacture of open hearth steel ingots, blooms, slabs, billets, hot and cold rolled steel, etc., will be required.

N. J., Kearny—FACTORY—Western Electric Co., 195 Broadway, New York, plans the construction of 4 or 5 new buildings as additions to plant here. Estimated cost $1,000,000 to $3,000,000. Condron & Post, 53 West Jackson Blvd., Chicago, Ill. are architects.

N. J., Perth Amboy — CABLE MANUFACTURING PLANT — Standard Underground Cable Co., 26 Washington St., is having plans prepared for a 1 story cable manufacturing plant. Estimated cost $200,000. Private plans.

N. C., Greensboro—PLANT ADDITION and BOILER HOUSE—Mock, Judson & Voehrunger Inc., Howard and Hiatt Sts., had plans prepared for additional unit to plant, also boiler house.

O., Cleveland—RAYON FACTORY—Industrial Rayon Corp., F. C. Niederhauser, V. Pres., West 98th St. and Walford Ave., awarded contract for a 1 story, 42 x 256 ft. addition to factory at West 98th St. and Walford Ave. to G. A. Rutherford Co., 2725 Prospect Ave. Estimated cost $110,000.

O., Cleveland—ELECTRIC CONTROLLER FACTORY ADDITION—Ohio Electric & Controller Co., 5900 Maurice Ave., awarded contract for a 3 story, 38 x 80 ft. addition to factory, to H. K. Ferguson Co., Hanna Bldg. Estimated cost $40,000.

O., Dayton — CASH REGISTER FACTORY—National Cash Register Co., Main and K Sts., is receiving bids for a 6 story, 80 x 480 ft. factory on K St. Estimated cost $700,000. Private plans.

Pa., Warren — COUPLING PLANT — Thomas Flexible Coupling Co., is receiving bids for a 1 story, 60 x 200, 40 x 100 and 40 x 60 ft. coupling plant. Estimated cost $100,000. Private plans.

Ont., Toronto—RADIO MANUFACTURING PLANT — Rogers Batteryless Radio Co., 90 Chestnut St., awarded general contract for the construction of a 2 story, 80 x 250 ft. radio factory on Fleet St., to Jackson-Lewis Co. Ld., Federal Bldg. Estimated cost $200,000.

Ont., Walkerville—RACK WAREHOUSE—Hiram Walker & Sons Ltd., plans the construction of a 10 story rack warehouse at Monmouth Rd. and Wyandote St. Estimated cost $200,000. Architect and engineer not selected.

Ont., Welland — TUBE FACTORY — P. Hersey Tubes Ltd., A. M. Mosley, Mgr., awarded contract for an 80 x 525 ft. addition to factory on Crowland St. to Gardiner Co., 22 Cross St. Estimated cost $150,000. Equipment will be installed.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE present market for power-plant supplies has a strong tendency to advance. There were few, if any, important price declines during the month. In electrical supplies, however, discounts have been increased by about five points, in the last month, on non-refillable fuses. Principal advances of the month affected the following materials: babbitt metal, genuine, highest grade, up 2c., to 69c. per lb. at New York; red and white lead (dry), up ¼c., to 13½c. per lb., New York; linseed oil, up 0.4c., to 11.4c. per lb., f.o.b., Chicago.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

½-in., per ft.	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30–10%
Heavy	30– 5%

RAWHIDE LACING—For cut, best grade, 30–5%; 2nd grade, 45–5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.16
New York (100 lb. bales)	.16
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.11	$0.11	$0.114

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.50	$15.00
White	13.50	13.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller list, (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, round head, per 100 lb.

New York	$4.50*
Chicago	3.60
Pittsburgh mill	2.90

*Price is for full packages; broken package lots, $6.00 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b., plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	59.00
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv	Inches	Iron Black	Iron Galv
1 to 3	62%	50½%	1 to 1¼	30%	13%

LAP WELD

2	55%	43½%	2	2%	7%
2½ to 6	59%	47½%	2½	26%	11%
7 and 8	56%	43½%	3 to 6	28%	13%
9 and 10	54%	41½%	7 to 12	26%	11%
11 and 12	53%	40½%			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	40½%	1 to 1½	30%	14%
2 and 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	25%	9%
2½ to 4	57%	46½%	2½ to 4	29%	15%
4½ to 6	56%	45½%	4½ to 6	28%	14%
7 and 8	52%	39½%	7 and 8	21%	7%
9 and 10	45%	32½%	9 to 12	16%	2%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	....	$17.07
1¼	.....	....	19 20
1½	.....	$38 00	17.92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	30.25	49 50	30 67
3½	31 50	52 75	33 33
4	38.03	67 00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3¼ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$29.50 (net)	$45 00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft	60%	35%
1,000 to 5,000 ft	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 5 per cent. additional; 10,000 lbs. and over delivered free.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7 76	$8.83	$4.52	$4.92
¾	72.07	78 63	10.21	11 63	6.46	7.03
1	103.31	113.00	15 10	17 21	8.39	9 13
1¼	139.77	152.88	20 51	23 07	11.78	12 75
1½	167.12	182.79	27 34	30 76	14.56	15 75
2	224.85	245.94	50 13	56 40	19 41	21 01
2½	355.50	388.85	82 03	92 28	27.73	30.01
3	464.88	508.50	218 74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$18.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13 00
No. 16 cotton reinforced light		18.00
No. 18 cotton Canvasite cord		14 60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft	$70.80	*76 70
No. 14 super service cord or similar (2 wire) in 1,000 ft	106.20	*115 05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0 15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 65%; one-fifth to standard package, 70%; standard package, 75%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carto Quantit
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt General Watts	Type	Price Each	200—260 Volt Special Watts	Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.25	$8.50	$10.50	$18.30
12	9.50	11.10	13.10	23.60
10	12.90	14.70	16.80	31.25
8	18.85	20.60	22.40	44.00
6	.....	.....	33.00	.....
4	.....	.....	46.80	.....
2	.....	.....	65.50	.....
1	.....	.....	88.20	.....
0	.....	.....	105.00	.....
00	.....	.....	126.00	.....
000	.....	..	152.00	.....
0000	.....	.....	184.50	.....

SOCKETS, BRASS SHELL—Price each, net:

	¼ In. or Pendant Cap Key	¼ In. or Pendant Cap Keyless	¼ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots.... 29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb..	100 lb. lots.... 31c per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	30.00

Discounts:	
Less than $25.00 list value	30%
$25 .00 to $50.00 list value	35%
$50.00 list value or over	40%